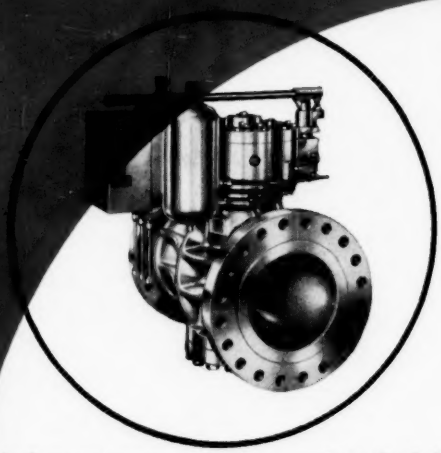
INSTRUMENTS and AUTOMATION

Including: Instrument Manufacturing • The Journal of the SCMA • Simulation Council Newsletter



Much recent progress has been made in the field of fully automatic control of large pipeline valves, both plug and gate types. . . . page 708

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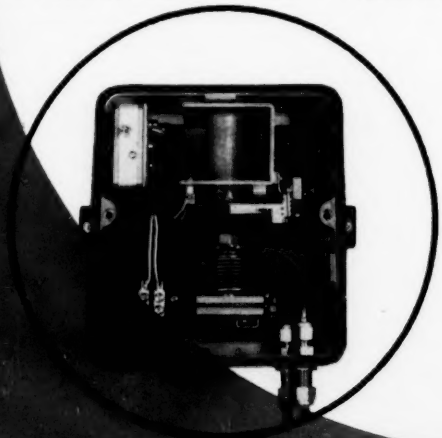
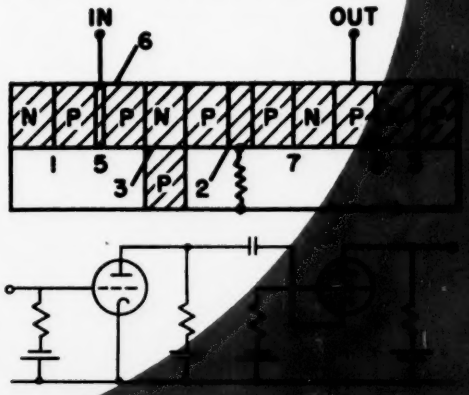
The program tells the computer where what to get, and what to do with it. The m makes no decisions for itself. . . . pag 671

A hybrid system may be the answer to the electric-pneumatic dispute. . . . electric transmission with pneumatic instrumentation. . . . page 678



Our real breakthrough in microminiaturiz will probably come from some totally ne proach using solid-state electronics. . . . pag 687



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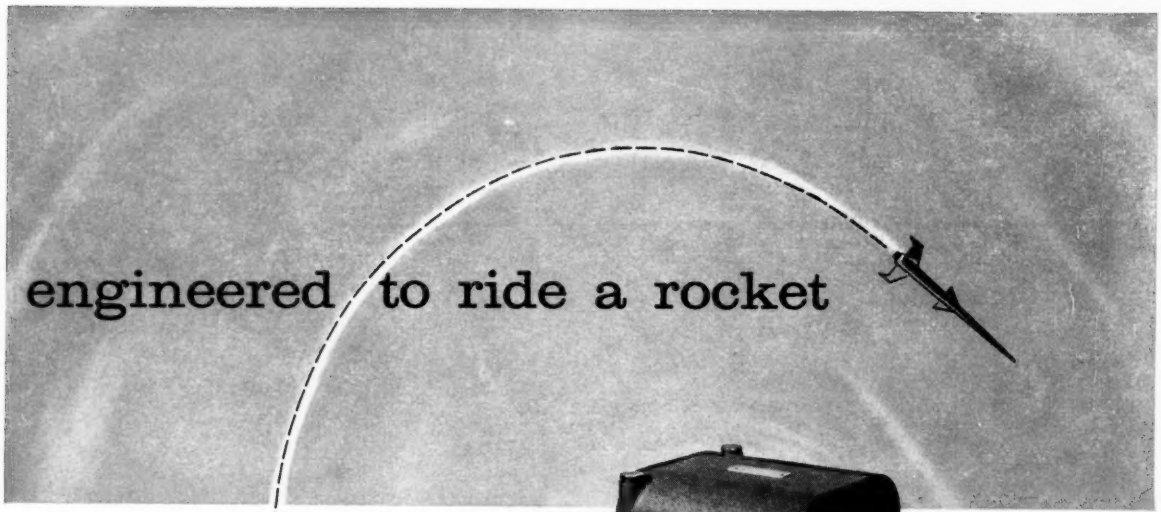
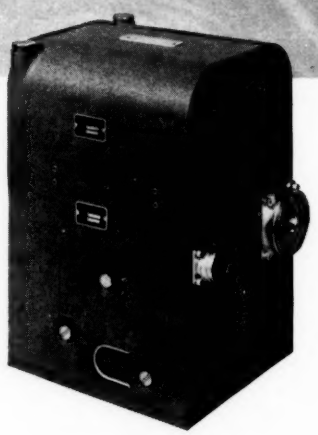


engineered to ride a rocket

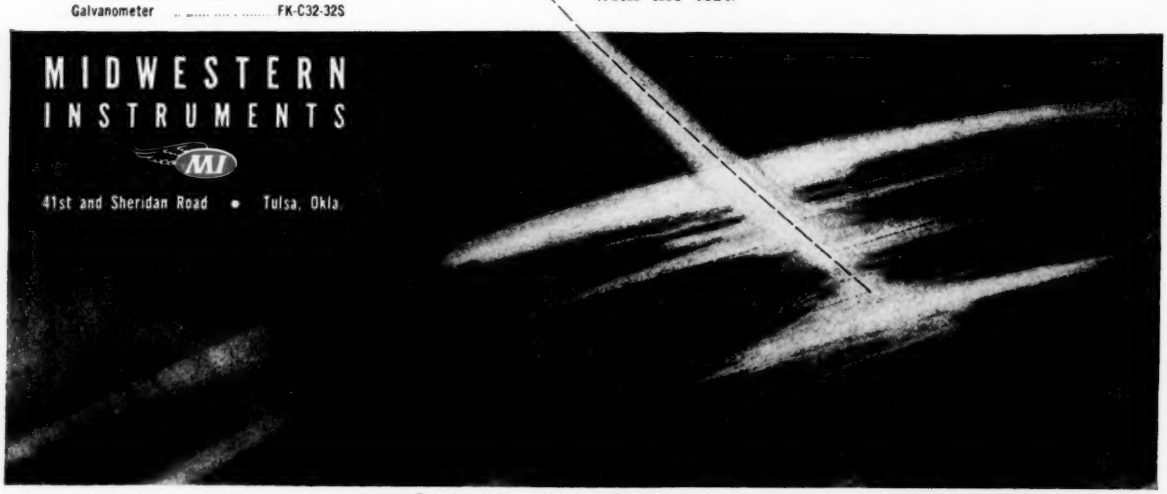


THE MIDWESTERN 561 RECORDING OSCILLOGRAPH

561 SPECIFICATIONS

Weight	15½ lbs.
Dimensions	6-11/32" x 5-3/16" x 9-3/16"
No. of Channels	14
Magazine Capacity	95' DuPont Lino Writ #4
Recording Speed Range	0.5" to 80" per sec.
Trace Identification	Beam Interrupter Type
Constant Acceleration	Above 25 Gravities
Shock Accelerations	Above 1500 Gravities for 20 Milliseconds
Temperature	—65°F to +165°F
Altitude	Up to 100,000' above sea level
Power Requirements	28 volts DC, 12 Amperes Maximum
Connectors:	
Power	WK-5-32S
Galvanometer	FK-C32-32S

This new recording oscillograph now makes it possible to eliminate costly telemetering equipment in missile, torpedo or similar testing. Its miniature size, extreme ruggedness and high recording speeds allow it to be installed directly in the test vehicle, where it will record all data and will withstand the high shocks and accelerations associated with the test.



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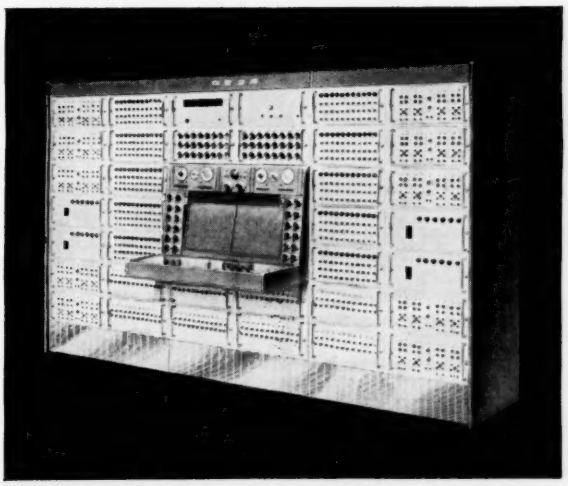

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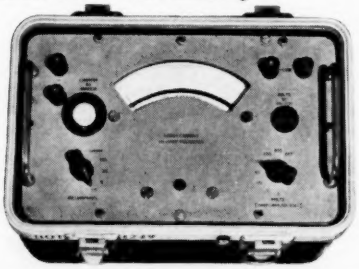

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EDITED FOR USERS OF MEASUREMENT AND CONTROL INSTRUMENTS

Volume 30, No. 4
April 1957

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

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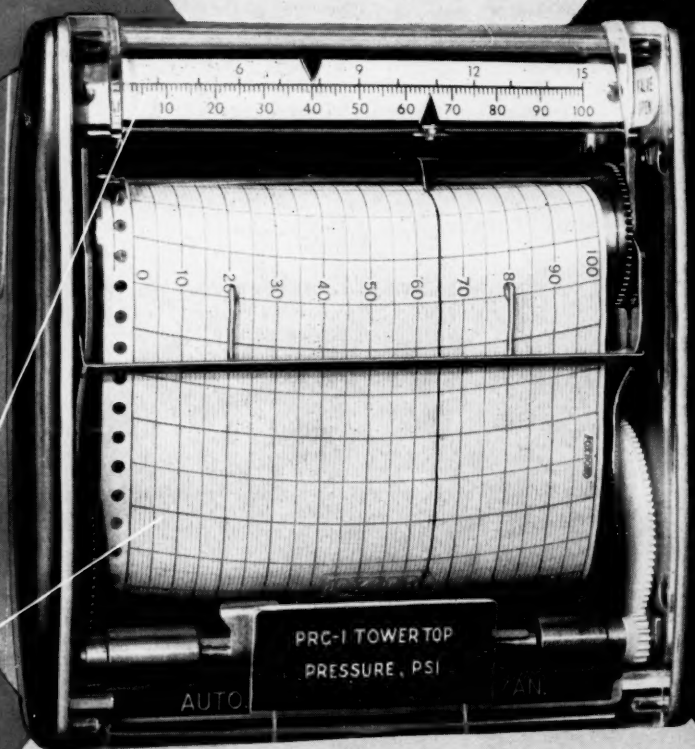

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- Indicating Control Station with automatic/manual transfer
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- Indicator — single or two pointer

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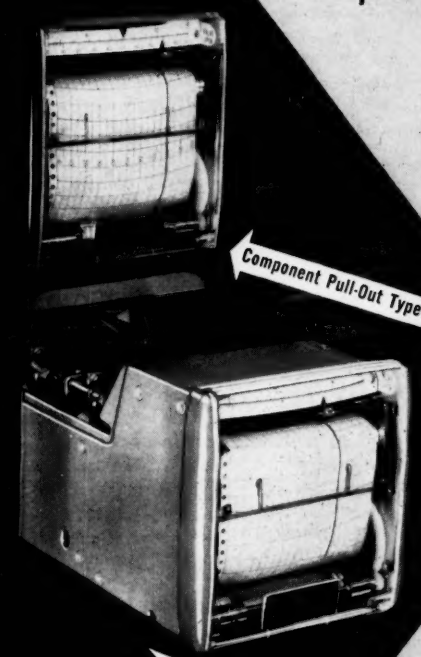
CONSOTROL

small-case panel instruments



Here's the "tops" in centralized recording and control efficiency! CONSOTROL Instruments require the minimum of valuable panel space, yet provide unsurpassed operator convenience, visual accuracy, and ease of maintenance . . . maintain the highest standards of precision and dependability. For example: the simple CONSOTROL method of switching from automatic to manual control requires no memory or extra operations . . . never "bumps" the process. All CONSOTROL charts and scales are full 4-inch width for greatest visibility . . . highest accuracy. When it comes to servicing, there's plenty of "finger room" . . . all parts are uncrowded and easily removable. And just compare inking requirements with other designs. CONSOTROL needs ink filling only once or twice a year! These are only a few of CONSOTROL's advanced design features — available in both fixed-mounting and full pull-out type instruments. Get the complete story. Write for Bulletin 13-18. The Foxboro Company, 464 Norfolk Street, Foxboro, Mass., U.S.A.

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Letters to the editor

Several times in the past we received inquiries for literature and technical assistance from a man in prison. Ordinarily, such a request would not be honored by us because a man in prison is not normally a user of instruments—but this man was not only abreast of modern developments in instrumentation, he also was working on an instrument project in the prison shop. We helped this man —and we learned from his correspondence that he was an avid reader and a capable technician. You may be interested in his "letter to the editor":

Editor, I&A:

Thank you for having gone to the trouble to obtain the data I requested on my previous inquiry card. I say "thanks" because you know that my address would, ordinarily, preclude any possibility of your advertisers gaining anything through literature sent to me. I derive much benefit: having discovered many years ago that to keep in "touch" with your job meant keeping informed of new advances and articles via reading matter and advertisements.

"Ordinarily," however, doesn't apply in my particular case. I am working on three definite assemblies which will enable some of your advertisers to benefit if the assemblies (designs) are accepted by the companies for which they are being designed, and if I use parts from advertising literature obtained through you inquiry service. As an example, Servo-Tek, of Hawthorne, N. J. will probably sell at least one of their ST-514-4 assemblies: because it seem ideally suited as the prime mover for the reciprocating feed used as one part of one unit in the processing line of one design. I say "probably" because I am working on a submission only basis.

It was my need for accurate information that caused me to write for *I&A*. These designs, being completely automated, required that I up-date my knowledge of prime movers, controls, materials handling, and presently available components. *I&A* can't be beat in any case, so far as I am concerned.

I have no doubt about sending you $4.00 for my subscription—100.17% of one month's wages! How many of your readers would pay a comparable price? Again, I repeat—your magazine is tops.

I was irked by a letter in the "Letters to the Editor" department of your November issue. It was from Phoenix, Arizona, and signed as "Unsigned." His plaintive crying can be read in his choice of words. He as much as says, "I want it all drawn out for me, and as it applies to my problems. It's too hard for me to THINK: either while reading *I&A*, or while looking for ways to apply the knowledge I can gain from reading *I&A*." His kind is always ready to blame anything other than himself for his refusal to use his God-given mind.

An engineer SOLVES problems, or he isn't an engineer: becoming, instead, only a highly trained maintenance man. The difference between the two shows up in the problems solved, or not solved. It is this criterion which proves that the college graduate many times is topped by the H. E. P. G. (hard-earned, practical-experience graduate).

Can you tell me where I can find the company which sells "current carrying track"? It is a three-wire system with an exposed side on each wire, or track. The contacts, coming from your motor, brush against these exposed portions as your motor moves. It is similar to the "plug in anywhere" baseboard wiring for houses.

G. S.

Editor, I&A:

I have heard several statements in which people hope that your series of tube circuits will ultimately be made into an encyclopedia of electron tube circuits. There is nothing on the market like that I know of and it would be extremely useful. I know my classes would buy it and that's 200 a year right there.

You would also be extremely pleased at the comments I hear on *I&A*. You are doing a terrific job.

Dr. Martin L. Klein
Rocketdyne Division
North American Aviation, Inc.

The entires series to date is now available in book form from The Instruments Publishing Company, 845 Ridge Ave., Pittsburgh 12, Pa. The title is "100 Electronic Circuits." The price: $2.00.

Editor, I&A:

The "Electronic Circuitry" data sheets would certainly be a lot easier to file in notebooks if you would print the information on both sides of the same page (back to back) instead of on two different pages which face each other.

V. E. Harms
Standard Oil Company
Mandan, N. Dakota

This idea is good, but our primary objective is easy reading for our magazine readers—and a two-page spread is easier to read than two pages back to back.

The entire series of 100 circuits to date is now available in book form, with all circuits indexed. For example, all amplifiers are in one section, as are pulse circuits, test instruments, etc. Its title: "100 Electronic Circuits."

Editor, I&A:

It seems a pity that the name of the great physical-chemical pioneer *Ostwald* has become so flagrantly degraded, cf. *INSTRUMENTS & AUTOMATION* vol. 30, pages 88-89, 1957.

F. C. Oppen
Wausau, Wis.

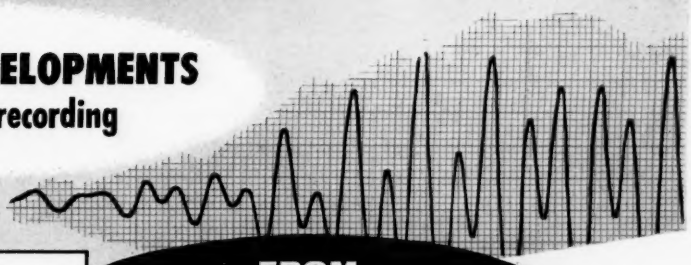
Wilhelm Ostwald, **born Sept. 2, 1853, chemist; father of physical, theoretical and electro chemistry, originator of theory of ionization, color chemistry; Nobel prize 1909. His work fertilized all branches of modern chemistry. Many an apparatus still used in analytical and colloid chemistry bears his name, such as: Ostwald conductivity cell, Ostwald capillary electrometer tube, Ostwald calibrating pipette, Ostwald viscosity pipette, Ostwald gas thermostat (for temperature control of conductivity baths), Ostwald-Folin pipette (for determining total nitrogen and ammonia in urin), Ostwald-Van Slyke pipette (for blood and urin testing), and Ostwald-Myers pipette (for delivery of measured quantities of plasma).**

Incidentally, the word "Oswald" also exists and has a dignified meaning. It is of ancient German origin and means "The divine ruler" ("Der gottlich Waltende"), according to Knauer's Konversations Lexikon *(Knauer's Dictionary).*

Wilhelm Ostwald's son, Wolfang Ostwald, born May 27, 1885, was himself a well-known chemist at the University of Leipzig, known for his work in colloid chemistry.

It is regrettable that Ostwald's name was misspelled "Oswald" in the article. The authors and editors apologize for the mistake—but the

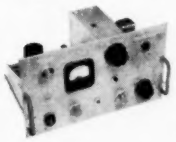
TECHNIQUES and DEVELOPMENTS
in oscillographic recording



FROM
SANBORN

PHASE SENSITIVE DEMODULATOR PREAMPLIFIER PROVIDES A DC VOLTAGE PROPORTIONAL TO AN INPHASE COMPONENT OF AN AC VOLTAGE WITH RESPECT TO A REFERENCE.

THE measurement of the amplitude of an AC voltage component is often necessary in performance studies of servo systems or of suppressed carrier signals over the carrier frequency range from 60 to 10,000 cps. In such cases the demodulator responds to inphase signals and rejects quadrature signals.



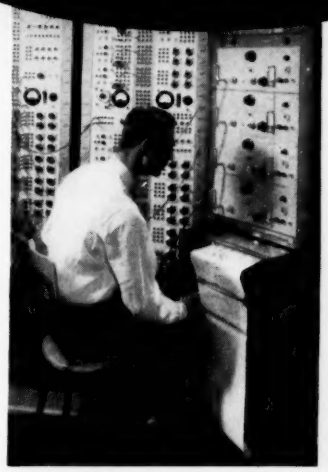
A circuit with these characteristics for use in an oscillographic recording system can be seen in the Model 150-1200 Servo Monitor (Demodulator) Preamplifier. It was developed by Sanborn as one of twelve interchangeable, plug-in front ends for "150" Series equipment, to be used with the appropriate Driver Amplifier-Power unit in any channel of a "150" system. Elements comprising the circuit from input to output, include: compensated stepped attenuator and cathode follower input circuit, phase inverter, push-pull mixer and demodulator stages, differential DC output amplifier and low pass filter. In addition, the chassis contains a VTVM to facilitate accurate adjustment of the reference voltage, and an overload indicator which lights a warning lamp when excessive quadrature voltages exist.

Adaptability to a fairly wide variety of applications is accomplished through broad input voltage, reference voltage and frequency ranges. In order, these are 50 mv to 50 v (for full scale 5 cm deflection), 10 v to 125 v; 60 cps to 10kc. Rise time with low frequency plug-in demodulation filter is 0.1 seconds; with high frequency filter, 0.01 seconds. Quadrature rejection is better than 100.1; for carrier frequencies up to 5000 cycles.

Two representative uses of the Servo Monitor Preamplifier are in the design and adjustment of servo systems, and with instruments used in the design, development or adjustment of other apparatus. The first is illustrated by use of the Preamplifier and associated equipment in the recording of the output shaft amplitude and driving frequency of an AC positional servo; the second by recordings made with a similar setup of the difference between output signals from a gyroscopically-controlled stabilizing device and the "pitch" and "roll" signals generated by a "Scorsby Table" used for testing the device under dynamic conditions.

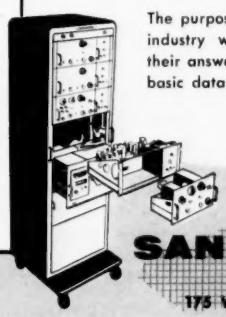
For a detailed discussion of the principles and design considerations involved in the Servo Monitor Preamplifier, refer to the February, 1955 issue of the Sanborn RIGHT ANGLE, for Dr. Arthur Miller's article on "Measurements with the Servo Monitor Preamplifier."

Technical literature and engineering assistance on specific problems are always available from our engineering department.



BASIC FACTORS IN SELECTING OSCILLOGRAPHIC RECORDING EQUIPMENT

WHEN considering any oscillographic system or equipment for your application, three useful "yardsticks" to apply are (1) the recording method, (2) equipment adaptability, and (3) variety of equipment available. Here are the answers to the three, as they apply to Sanborn systems. In the record, rectangular coordinates accurately correlate multiple traces, simplify interpretation and eliminate errors. Permanent traces, produced by a hot ribbon stylus without ink, provide sharp peaks and notches, and clearly reveal all signal changes. One percent linearity results from current feedback driver amplifiers and high torque galvanometers of new design; maximum error is ¼ mm in middle 4 cm of chart, ½ mm across entire chart. From the standpoints of "adaptability" and "variety", Sanborn "150" equipment offers the versatility of 13 different plug-in front ends for any basic system . . . the choice of one- to eight-channel systems . . . the variety of nine chart speeds, timing and coding controls, console or individual unit packaging . . . availability of equipment as either complete systems or individual amplifier or recorder units.



The purpose of the foregoing information is to better acquaint industry with typical oscillographic recording problems and their answers, design considerations in Sanborn equipment, and basic data on what Sanborn makes and how it is being used.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 WYMAN STREET, WALTHAM 54, MASS.

For more information circle **6** on inquiry card.

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GENERAL ELECTRIC

above should restore Wilhelm Ostwald to his proper position in the mind's of today's instrumenticians. Thank you Mr. Oppen.

Editor I&A:

May I call your attention to an error on page 461 of your March issue.

The example given for conversion of a decimal to a binary (27 = 11011) happens to be symmetric, but actually the method works only proceeding from right to left, and line 4 from below should, therefore, read:

6/2 = 3 remainder 0, giving . . . 011 (not 110)
3/2 = 1 remainder 1, giving . . . 1011 (not 1101).

Larry K. Bonhard
Brooklyn, New York

Mr. Bonhard (and many other readers) caught this basic mistake in the "halve and save-the-remainder" technique for converting a decimal to a binary. Always start from the right, not the left. As another reader wrote:

To double-dabble I was able,
To dabble-double caused me trouble.

Editor I&A:

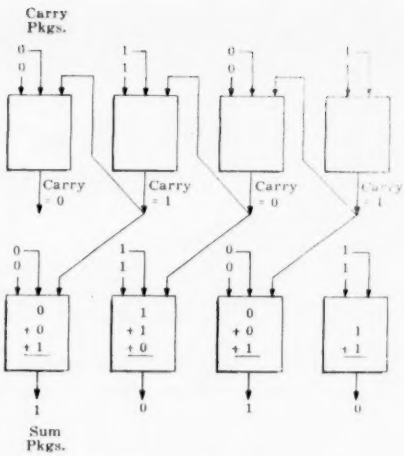
The article "Symbolic Logic" in your March issue was indeed clear, educational and, for me, an introduction to new concepts. But I do not understand one statement in that article regarding parallel addition, as follows: "two numbers enter the parallel adding system of Fig. 12 repeatedly for as many pulse periods as there are carries."

Leroy Walkow
Pittsburgh, Pa.

This statement is in error. Here is the way the "parallel adder" really works:

The two numbers to be added (addend and augend) exist at the input for only one pulse period. Referring to Fig. 12, one adder chain creates the "pseudo sum"—that is, the sum without carries; the other adder chain creates the "Carry." In a second pulse period, the pseudo sum and the carry are added again in similar manner—to develop a second pseudo sum and still other carries. If any new carry develops, the process is repeated until there are no further carries. The problem is then solved.

The following example shows how this is done:



011 101	Addend
010 101	Augend
001 000	Pseudo Sum #1
1–1 –1–	Carry #1
100 010	Pseudo Sum #2
–1– ——	Carry #2
110 010	Pseudo Sum #3
000 000	Carry #3
110 010	End of problem

As no carries are developed in the third pulse period, this sum is the final sum. The logic of the sum and carry packages employed in each stage was shown in Fig. 11. The adder packages respond automatically and do not require external circuitry.

The time required to perform the addition depends on the "pulse period" or inherent delay used. In the 3C-PAC equipment, each inherent delay is 1 microsecond; hence this addition would have required 3 microseconds. The package delay can be reduced in half by two-phase clocking, if desired; or in quarter by four-phase clocking, etc.

In the worst case, the carry may have to be cleared throughout the entire number, as follows:

1 111 111	
1	
1 111 110	Pseudo Sum #1
1	Carry #1
1 111 100	Pseudo Sum #2
1	Carry #2

Etc.

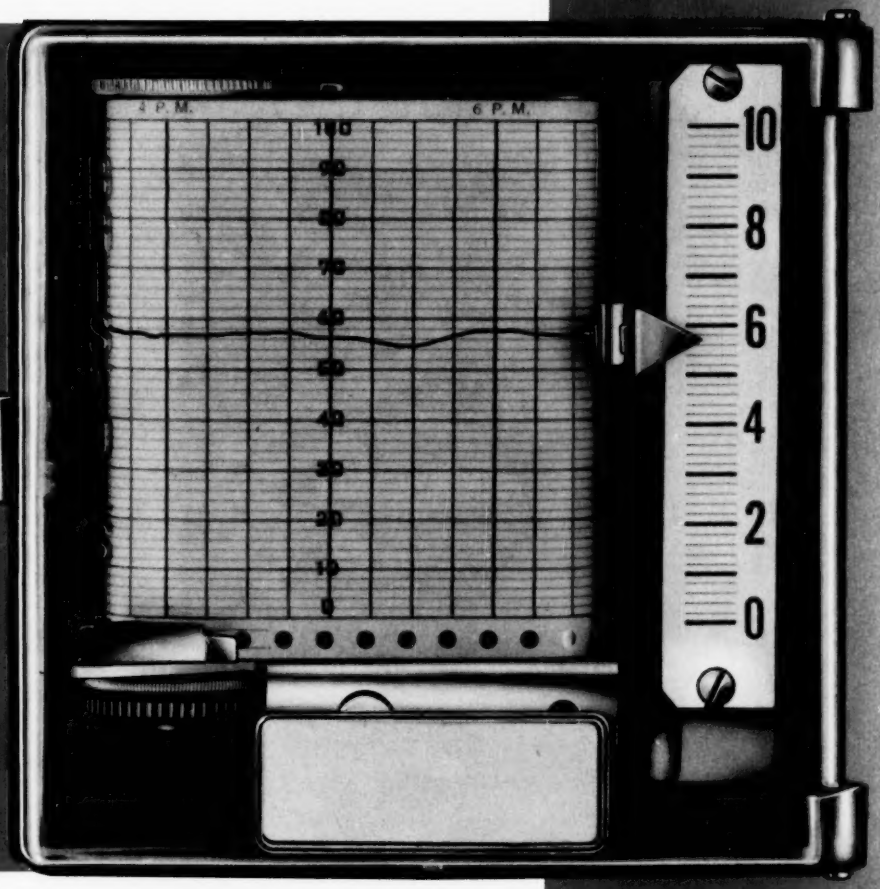
Note that seven delay intervals would be required for this 7-bit problem to reach its final answer of 10 000 000

In the best case, only two delay intervals are required:

1 111 111	
1 111 111	
0 000 000	Pseudo Sum #1
11 111 11–	Carry #1
11 111 110	
00 000 000	Carry #2
	End of Problem

Circle 7 on inquiry card. ⟶

Another BRISTOL First...



ACTUAL SIZE.
Only 5" x 5⅛",
mounts on 6⅛" centers!

First true motor-driven self-balancing electronic instrument in miniature size!

USES 3-INCH CHART, HAS FULL PLUG-IN FLEXIBILITY!

It's the new Bristol Series 663 Miniature Electronic Dynamaster® Instrument—now available in both indicating and recording models.

No delicate, low-torque galvanometer-type drive unit in this instrument! *The 663 employs motor-driven slidewire self-balancing — the same principle that's been time-proved for superlative accuracy and dependability in full-size Dynamaster instruments.* All in a panel space only 5" x 5⅛"!

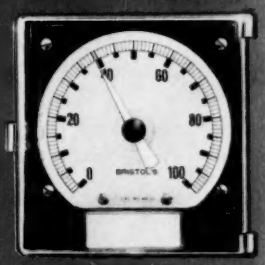
With this advance, Bristol steps ahead on two fronts:

1. Bristol now offers the widest selection of miniature plug-in instruments on the market — electronic, pneumatic, and telemetering (all with the same panel cutout) — you can get them all from Bristol.

2. Bristol becomes the first manufacturer to offer both full-size and miniature instruments in a full line. Your instrument problems get unbiased recommendations from Bristol — every time!

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE

*T.M. Reg. U.S. Pat. Off.



SAME INSTRUMENT
also made as an indicator.
See next page.

Turn the page
for features on this exciting instrument development.

CHECK These Features of the new 663 DYNAMASTER . . . most of them found on no other miniature electronic instrument!

1. **True motor-driven self-balancing operation.** Null-balance mechanism uses high-torque, two-phase motor, *not* galvanometer-type drive unit.

2. **True plug-in chassis.** You can interchange chassis in seconds; thus, you simplify maintenance, remove overhaul to shop where it belongs. Or, you can change from recorder to indicator (or vice versa) just as quickly.

3. **High accuracy.** ½% of scale — twice as accurate as ordinary miniature electronic instruments.

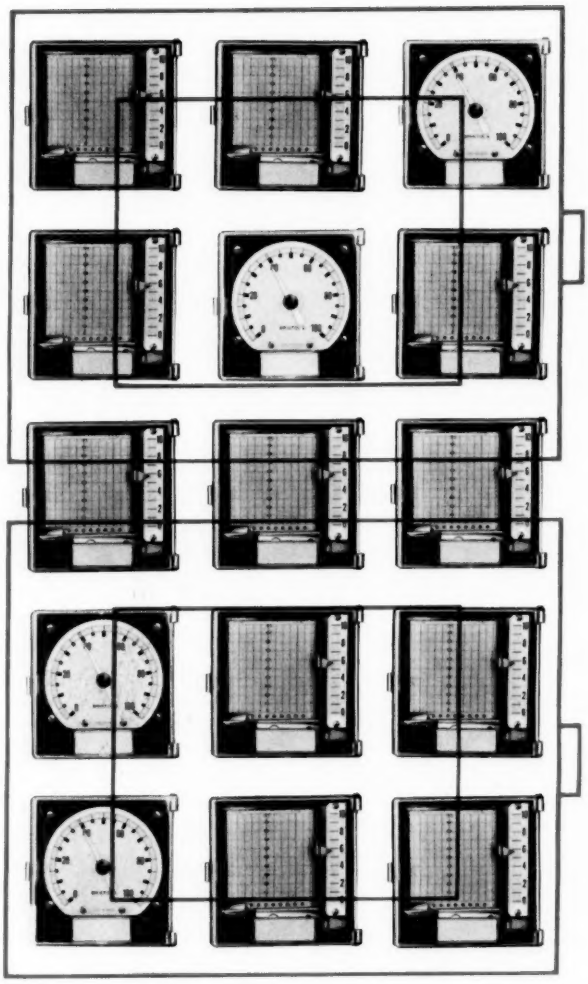
4. **High-torque gradient and low dead band (0.15%).** Plenty of torque for operating alarm contacts, retransmitting slidewires, and electric control contacts.

5. **Field-interchangeable range cards,** easily accessible without special tools or skill, make instrument versatile in application.

And last but not least, the new Series 663 Dynamaster instruments give you all the features that have made Bristol a by-word among instrument men. For example; building block construction and completely interchangeable parts speed servicing. Human engineered dials and charts make reading easy, accurate.

Write for the complete story on the miniature Bristol Series 663 Electronic Dynamaster instruments. And remember, for either electronic or pneumatic graphic-panel-type instruments, Bristol has the widest line on the market. The Bristol Company, Waterbury 20, Conn.

NEW INDICATING MODEL in the Series 663 is completely interchangeable with recorder of similar characteristics Takes just 10 seconds to remove recorder and plug-in indicator, or vice versa.



Now you can mount 15 miniature electronic instruments in space taken by 2 conventional electronic instruments (shown by red outline). Both give equal performance. New Bristol Series 663 recorders and indicators are full-size electronic instruments in everything except actual physical dimensions; are the only 3-inch chart electronic instruments using true motor-driven self-balancing mechanism.

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

LETTERS—CONTINUED

Editor, I&A:

Work is being done by the AIEE Feedback Control Systems Subcommittee on Definitions, Symbolisms, and Specifications.

Broader knowledge of the activities of the Feedback Control Systems Components Subcommittee throughout the control systems field should encourage systems and component designers to a more ready acceptance of the idea of specifying dynamic performance of control system components. Anything you can do through *Instruments and Automation* to make this information generally available will be greatly appreciated by the AIEE Feedback Control Systems Subcommittee.

The following AIEE components subcommittee members have the assignments noted below:

Gyros
Robert Keeler
Minneapolis-Honeywell
Aero Division
Minneapolis, Minnesota

Hydraulics
Warren Gaines
General Electric
Aircraft Products Department
1 River Road
Schenectady, New York

Andrew A. Seleno
Vickers Incorporated
Administrative and Engineering Center
Detroit 32, Michigan

Thank you for your cooperation in this matter.

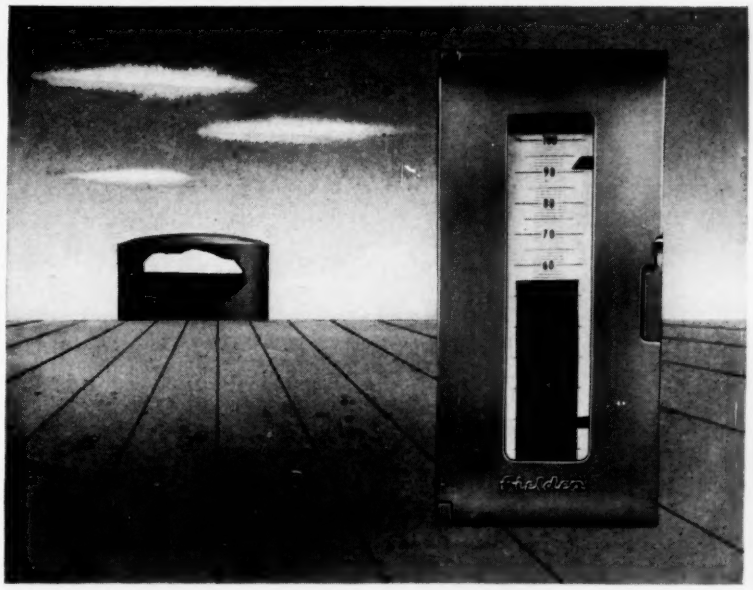
Harold Chestnut, Chairman
AIEE Feedback Control Systems Subcommittee on Definitions, Symbolisms, and Specifications
General Electric Company
1 River Road
Schenectady 5, New York

Editor, I&A:

February, 1957, issue of *Instruments and Automation* has just been received. The article by James R. Bright, "Myths of Automation," is superb . . . and gives me backing for some work I may be called upon to do. That article alone is well worth the subscription price and more.

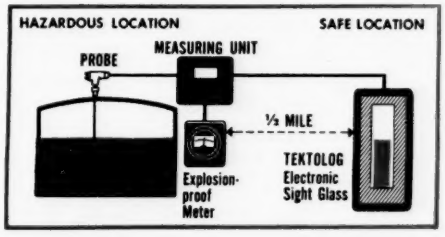
Everett S. Lee
Schenectady, N. Y.

Now See Level "Inside" Vessels from Panels ½ Mile Away



With a new Fielden unit, the level of any liquid, powder, interface, or granular solid can be measured accurately in any area . . . and reproduced visually as far as ½ mile away.

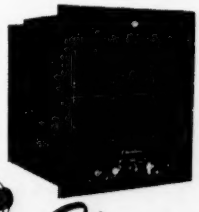
This equipment now enables you to combine all the advantages of capacitance level measurement with the convenience of 8½" vertical scale indication and control. Level is measured and indicated locally and/or remotely by a Fielden Series 10 TELSTOR, Series 42 Null Balance or Series 16 Continuous Level Telemetering System. A TEKTOLOG Electronic Sight Glass of panel space-saving design then shows level graphically by means of a moving colored tape.



Features

- TEKTOLOG Electronic Sight Glass available for electric control with up to 4 separate points
- Indicates level of any material—conducting or non-conducting
- Measures entire span or any portion—up to 150 or 200 feet.

Fielden "gradated" instrumentation



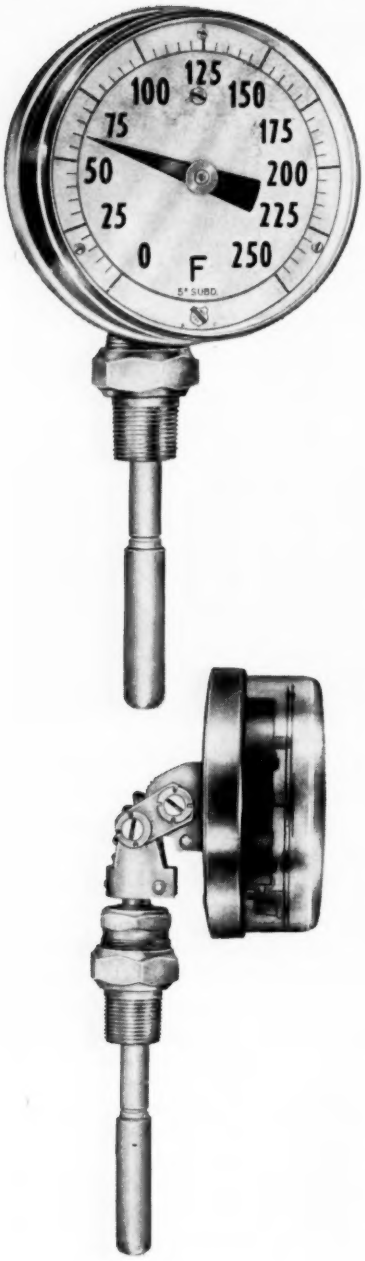
Whatever the process temperature, Fielden instrumentation is "gradated" to provide needed accuracy and functions at lowest cost. Measuring instruments start with voltage or current indicators and recorders . . . step up to null-balance recorders for up to 96 points . . . and range all the way to manual monitors and automatic scanners.
Fielden controllers can take you all the way from electric on-off control . . . to cascade control . . . right up to pneumatic proportional control. Fielden also offers telemeters, a revolutionary pneumatic electric transmission system, and a full line of pyrometer accessories and supplies.

Robertshaw-Fulton CONTROLS COMPANY

Send for Literature
FIELDEN INSTRUMENT DIVISION
Dept. A, 2920 N. 4th St., Philadelphia 33, Pa.

For more information circle **8** on inquiry card.

← Circle **7** on inquiry card.



NEW

MERCURY ACTUATION

IN A MODERN 'AMERICAN'

"Every Angle" DIAL THERMOMETER

If you expect the most for your money in readability, accuracy and durability, here is the best dial thermometer investment you can make. The 'American' Mercury-Actuated "Every Angle" Dial Thermometer provides a combination of five major advantages found in no other thermometer:

"Every Angle" Set-ability. You can turn the dial to any angle within 180° on two axes. Whether installed above or below eye level — to the right or left of the reading point — you get easy face-to-face readings.

Fast, Accurate Indication. Mercury — one of the most sensitive heat transfer mediums — makes possible readings up to 1000° F. in a few moments with accuracy within 1% of the entire scale range.

Surest, Sharpest, Easiest Readings. The Maxivision® dial — a split-level dial — is constructed so that the graduations and pointer are on the same plane. No perspective effect. No parallax error in reading.

Best in Visibility. The cover is a large, durable, clear glass dome without bezel. No dark shadows dim the dial to hinder reading accuracy.

Stainless Steel Construction. Movement, capillary tubing, stem, case and cover mounting — all are stainless steel.

Where resistance to corrosion is important, where appearance and cleanliness are essential, the 'American' Mercury-Actuated "Every Angle" Dial Thermometer is ideal. It is rugged — has every quality required for the toughest services, indoors and outdoors. From the standpoint of economy, the "Every Angle" feature alone can save money in new piping specifications and when changing existing piping. It reduces the need to re-specify and stock a variety of fixed stem thermometers.

Dial Size: 4½". *Temperature Ranges:* –20/120° F. to 200/1000° F. *Stem Lengths:* 4", 6", 8", 12", 18" and 24". Separable sockets available.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has complete information on the 'American' Mercury-Actuated "Every Angle" Dial Thermometer. Call on him to fulfill your requirements with fast delivery from local stocks.

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn., and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **9** on inquiry card.

NEW! ultra-stable FM Telemetering Discriminator*

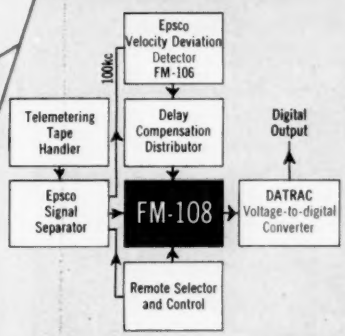
**Epsco Model FM-108 FM-to-Voltage Converter.*

EPSCO'S MODEL FM-108 crystal-controlled ultra-stable, all-channel discriminator presents a new *standard of accuracy* . . . better than an order of magnitude more accurate and stable than any other commercially available equipment . . . and with absolutely *no* adjustments! This new standard of FM data processing features:

- **HIGH DYNAMIC ACCURACY:** Absolute accuracy is better than 0.05%, and the dynamic accuracy of the equipment from input to associated band-pass filter through the low-pass output filter is better than 0.2%.
- **LONG-TERM STABILITY:** 0.2% for life of equipment with no adjustments for zero drift, gain and line voltage variations, etc.
- **VERSATILITY:** Converter operates on any of 23 standard IRTWG telemetering sub-carrier frequencies from 400 cps to 70kc. Band switching may be accomplished remotely or by selector switch on front panel.
- **AUTOMATIC WOW and FLUTTER COMPENSATION:** With Epsco FM-106 Velocity Deviation Detector and Epsco CD-601 Velocity Deviation Compensation Distributor, errors from tape speed variations are reduced by a minimum of 35 db.
- **ZERO and 100% DATA CORRECTION:** Produces automatic compensation for variation of transmitting sub-carrier oscillator frequency and gain by a transistorized electro-mechanical servo feature.
- **DYNAMICALLY ACCURATE SELECTABLE LOW-PASS FILTERS:** A 5-pole filter utilizing precision wire-wound resistors and ultra-stable polystyrene capacitors in combination with chopper-stabilized d-c amplifiers provides:
  - Phase linearity deviation not exceeding 0.25 degrees over 90% of bandwidth.
  - Pass band flat within ±0.1% (0.01db) to F_c.
  - Minimum attenuation of 54 db of nearest beat frequency between sub-carrier channels.
  - A total of 62 different low-pass filter bandwidths selectable from 11 cps to 3490 cps.
- **PHYSICAL CHARACTERISTICS**

  SIZE: 10½" of space of standard 19" cabinet.
  WEIGHT: 29½ pounds.
  CONSTRUCTION: Constructed of 8 separate plug-in chassis assemblies containing electronic and magnetic components. All components are accessible on the standard layout forms.

Engineering data sheet available on request.



Epsco Model BF-601 Signal Separator units, each of which contains 23 band-pass filters, are available for separating the composite sub-carrier signal prior to input to FM Converter.

Complete FM telemetering receiving stations are available with or without wow and flutter compensation and zero and 100 percent correction features. Also available is the Epsco Model VCO-718 All-Channel Voltage-Controlled Oscillator for FM Discriminator calibration . . . which occupies only 3½ inches of panel space including power supply.

In the West, contact:
Epsco Service Corporation of California
1722 Westwood Boulevard
Los Angeles 24, California

Epsco incorporated

588 COMMONWEALTH AVE., BOSTON 15, MASSACHUSETTS

For more information circle **10** on inquiry card.

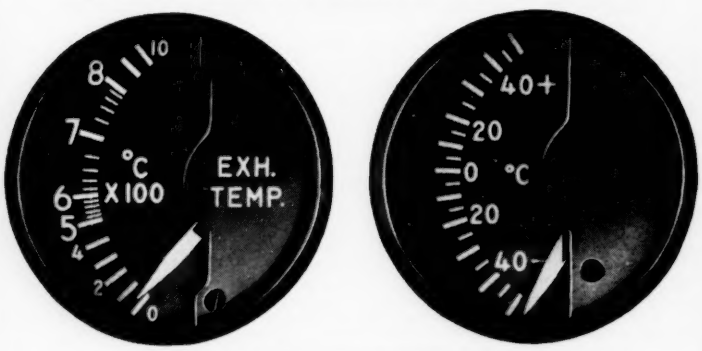
for improved readability, specify
the new **LEWIS**

LONG SCALE

aircraft temperature indicators

- Standard AND10412 cases
- Scale arc approximately 250°
- No auxiliary components
- No vacuum tubes
- Operate the same as conventional thermocouple type or resistance type temperature indicators
- Interchangeable with conventional temperature indicators, use standard resistance bulbs or thermocouples and leads
- Made to Military Standard Specifications
- Tested and Approved

COMPARE the improved readability of these long scale indicators with these . . .



Conventional indicators

Recognizing the need for improved readability without increasing panel space requirements, The Lewis Engineering Company has developed these completely new Aircraft Temperature Indicators both in the Thermocouple Thermometer type and in the Resistance Thermometer type.

the **LEWIS ENGINEERING COMPANY**
naugatuck, connecticut

For more information circle **11** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Total transistor production in 1957 is expected to be 30 million units; may reach 300 million units by 1965. Transistors registered with the Joint Electron Tube Engineering Council (JETEC) now number 165, with 14 companies either manufacturing or planning manufacture. More than half were registered in 1956. Five leading companies— GE (18%), TI (14%), RCA, CBS-Hytron and Sylvania—account for more than 50% of all registrations; 54% of registrations are PNP types; 33% are NPN types; 13% are point-contact types.

Present U.S. railroading trend is to diesel operation. Nearly 30,000 diesel units have replaced all but 4000 steam locomotives. Even electric locomotives have decreased in number from 700 to 500. Electrified roads are decreasing, with 1300 miles of track dropping electrification in last decade.

Communication equipment, including microwave relay and scatter propagation equipment, are due for extensive growth in the next ten years—from $200 million to an approximated $350 million in 1956, says Dr. W. L. Barrow, VP for R & D, Sperry Gyroscope Corp. Industrial automation now has $112 million sales annually, with closed circuit TV at $3 million; by 1965 automatic machine tool controls, process controls and other industrial instruments should reach $340 million, with closed circuit TV over $20 million. Business data-processing and general purpose computers is now about a $125 million market; but is expected to grow to $650 million annually in 10 years.

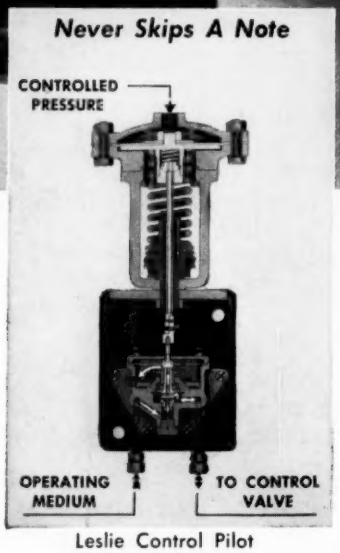
Optical industry predicts record 1957 volume because of bench tools required by the electronics industry for miniaturization and automation, and increased use of optical instruments in industrial research.

1957 estimates for nuclear industry: mining and milling uranium—$120 million; other nuclear research—$30 million; military reactors—$140 million; total—$530 million.

The Atomic Energy Commission reports that requests for access permits, principally to enlarge the scope of access to nuclear materials, rose to 35 per month during the first half of 1956, from 10 per month for the last half of 1955.

Solid-state phenomena are an increasingly fertile field of electronic research. Semiconductor devices, unknown five years ago, netted $60 million in 1956. More revelations are due in new phosphors, photoconductors, and solar conversion cells.

Here's a Quartet of Control Pilots that Sings a Song of Savings



Leslie Control Pilot
Type PDA
Sectional View

NEVER A DISCORDANT NOTE from this quartet - - - they're always in tune - - - each unit doing its part to create 24-hour-a-day harmony. They save time — no personal attention or manual assistance required after they're set. Pressures stay at set point for top efficiency of process equipment in the line. Positive response of pilot and valve assures smooth throttling action within closely held limits.

The same smooth action and accurate control is provided even when extreme reductions are necessary (there are Leslie installations handling reduction of 2150 psi. to 5 psi. in one step!) Responds to pressure deviations as small as .025 psi., depending on pilot range.

For more information on controllers that save maintenance dollars, consult the nearest Leslie Engineer listed in your classified telephone directory under "Valves" or "Regulators". Use this help for economy in temperature and pressure regulation.

Bulletin 5303 sings the whole song. Send for it today.

TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

For more information circle **12** on inquiry card.

NEW HP-30 PYROMETERS offer high accuracy and close reproducible control—yet have been reduced more than 50% in size and 10% in cost.

NEW FROM GENERAL ELECTRIC . . .

Pyrometers that give low cost temperature regulation

Type HP-30 Pyrometers fulfill industrial furnace operators' requirements of close control at **low cost.** Installation and maintenance costs are low too.

The HP-30 may be connected from front or rear terminals, has automatic adjustment for thermocouple lead length resistance. Plug-in components and printed circuits make possible simple, easy maintenance.

Extremely flexible, the new series of pyrometers also offers flush or surface mounting, interchangeable control forms, and range changes that can be made in the field.

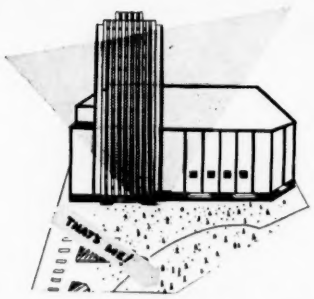
The HP-30 is an adaptable instrument that features a variety of uses. Six basic control forms are available, and special variations to solve specific control problems (speed, vacuum and voltage for example) are available on request.

For further information, write to Section 587-7A, General Electric Company, Schenectady 5, N. Y., or contact your nearest General Electric Apparatus Sales Office.

GENERAL ELECTRIC

For more information circle **13** on inquiry card.

Panhandle Pete At The IRE Show



Waldo Klapsaddle and I went to this IRE Show in New York because we want to keep abreast of all latest developments (if I thought my boss didn't read *INSTRUMENTS & AUTOMATION* too I'd tell you the real reason).

So I loaded my camera, put a notebook in my pocket, Waldo and I paid our three dollars and got into the hall and walked and sat through an awful lot of stuff. You know, once you've seen one of these affairs, you've seen them all. A lot of strangers all dressed up on a week-day with identification cards pinned on their lapel and feeling self-conscious for it.

Ran into two of my friends looking for jobs (don't you believe all you read in want ads for engineers). They were reading the many ads pasted on the wall of the first floor, trying to entice $7000 engineers to move to sunny Los Angeles (??) for $30,000 that turns out to be $7075. Some of these companies will actually pay you for an introduction to an engineer who is unhappy with his present position. As there are many such homo technisaps in my immediate vicinity, I am now dickering with these manhunters for a quantity price on introductions.

One company got real interested in Waldo because they need a sales manager—and Waldo happened to mention that he is a sales manager. Before Waldo could explain that all he has sold to date is a line of Aves Gas Analyzers, this company had him all signed up for a two-day test that their "personnel consultant" was giving to a group of 28 applicants for that particular job. (Our field sure is changing fast—it used to be when you wanted a job you just wrote out what you could do and then talked to the boss-man. No sir, now you take a 2-day test from a consulting specialist on personnel systems!)

On the first day they gave Waldo a long test that proved out his I.Q. and salesmanship. One of the questions was "name the six most important requirements for a salesman."

To which Waldo answered:

1. Buy all the meals.
2. Entertain the customers.
3. Lite the cigarettes, especially the customer's wife.
4. Purchase booze at the right price.
5. Listen to old stories and laugh.
6. Have an understanding wife.

Don't know why they didn't ask Waldo back the second day for the rest of this test—where they have the applicant act out a sales pitch to the purchasing agent for hermetically-sealed gyrosopically-stabilized servo-mechanism-driven antenna platforms. Waldo's feelings were hurt too—but I told him that company wants an actor, not a sales manager.

But to get back to the technical exhibit, something new in the exhibit end of the show were the female employees of the various companies showing themselves at the booths. And then—wait a minute. That doesn't sound right, does it? They weren't showing themselves; they were demonstrating their equipment. Oops, no they weren't, they were showing the customers the products which the companies they work for make.

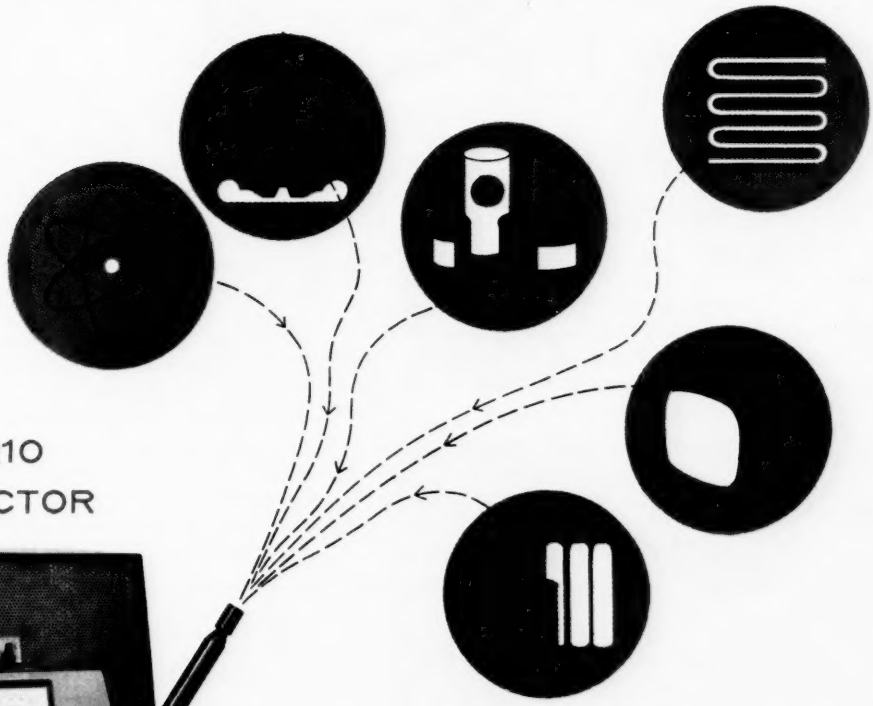
The high spot of the show was the party throwed by the H-H Company. This event was so colossal, so—adjectives fail me. The food, the hostess, the liquids, the hostesses, the accordion player, the hostesses—all these beggar the description. My oh my. The amazing thing about all this is that I got home in one piece and with my camera intact.

All in all I sure learned a lot about electronics, and I'm glad to pass this information on to you.

Panhandle Pete

(Courtesy Ed Fisher and *The Saturday Review*)

Easiest, most economical way to leak-test your product



CEC'S 24-210
LEAK DETECTOR

Unlimited applications in leak detection

Now you can test your product for vacuum seal, or locate leaks in any pressurized system with pinpoint precision and practical economy. CEC's 24-210 gives you highly sensitive leak detection and long, trouble-free service. Compact and highly simplified, this low-cost, mass-spectrometer-type instrument detects leaks so minute that 50 years would be required for 1 cc to escape. Easy, convenient operation requires no special training or experience. Just plug into a 115-volt, 60-cycle line. Find out how fast the CEC 24-210 Leak Detector pays for itself. For detailed information contact your nearby CEC field office or write for Bulletin CEC 1830-X18.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **14** on inquiry card.

INSTRUMENTS and AUTOMATION News

Principles & Applications ....600 to 612
Stock Report 612
New Plants & Mergers 618
People in the News 623

Low-Cost Infrared Steals Pittsburgh Analytical Show

PITTSBURGH, PA.—Eighth Pittsburgh Conference and Exhibition on Analytical Chemistry and Applied Spectroscopy, held March 4-8, has developed into the country's leading convocation on the subject of analytical instrumentation. About 3,000 chemists and spectographers registered for the conference and exhibit, featuring 50 exhibits.

Last year the big analytical news of this show was vapor chromatography; of course, interest remained high in the many new chromatographic instruments exhibited this year by Beckman, Perkin-Elmer, Consolidated Electrodynamics, and others. In view of the heavy behind-the-scenes work now underway on the application of gas chromatography in process-control work, this subject soon will be in the news. However, the big news this year is low-cost infrared, with Perkin-Elmer ($3850), Beckman ($4950), and Baird ($7850) all unveiling exciting double-beam infrared spectrometers in this "bench" price range. This puts infrared, the most powerfull analytical tool available, in the bench instrument class, which should be welcome news to chemists and analysts in general. There are now about 2000 infrared spectrometers in use in the U. S.; we predict sales of 500 to 1000 of these low-cost analytical instruments in the U. S. in 1957.

New Material Discovered Harder Than Diamond

NEW YORK, N. Y.—Dr. Robert H. Wentorf, a member of the team that succeeded in synthesizing diamonds in General Electric's Research Laboratory is credited with the discovery of "Borazon," a new material which scratches diamond. Being in the same general range of hardness as diamond it is many times harder than the next-ranking materials in the hardness scale.

Diamond (No. 10 on Mohs' scale), being basically carbon, literally "burns up" in air at about 1600° F. Borazon can withstand temperatures of more than 3500° F and thus should be better for many industrial applications. "Super-pressures" above 1,000,000 psi and temperatures exceeding 3000° are used to produce crystals of boron nitride with a structure that is not hexagonal (like graphite) but cubic (like diamond).

X-ray diffraction tests of borazon reveal that the alternate atoms of boron and nitrogen are packed together almost as closely as the carbon atoms in diamond. The density is also about the same as diamond.

4th International Automation Exposition and Congress Set For N. Y. Coliseum, June '58

An International Automation Congress will be held in New York City June 9 to 13, 1958, as an adjunct of the Fourth International Automation Exposition. The Exposition will be held in New York's giant new Coliseum during the entire week. Planning to attend are creators and users of automation from many countries of the world, who expect to exchange ideas and information. Many of these experts will assist in providing guidance for executives, labor leaders and educators who will be present.

Already included are an extensive series of conferences, clinics and meetings which will be integrated with the exhibits to be displayed at the Fourth International Automation Exposition.

Management for the Fourth International Automation Exposition as well as for the associated events of the International Automation Congress will be Richard Rimbach Associates. It will continue the policies pioneered at the previous International Automation Expositions.

Of particular importance will be the many clinic sessions held in front of the exhibited equipments. The Automation Expositions held in 1954, 1955, and 1956 were noteworthy in advancing the clinic concept to the point where other exhibitions now realize the high educational value of such comprehensive education. Two-hour lecture-demonstration clinic classes will again be held in front of the many computers, data handlers, servomechanisms, controllers, and other automation equipments to be displayed.

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ACTUALLY THREE REGULATORS IN ONE—*PLUS* MULTIPLE SENSING!

The APR 1010 combines many *new* regulation and sensing systems in *one* versatile package. Here's flexibility of operation never before possible . . . saves space, eliminates instrument duplication, means greater economy in engineering operations.

- **RMS VOLTAGE REGULATION**
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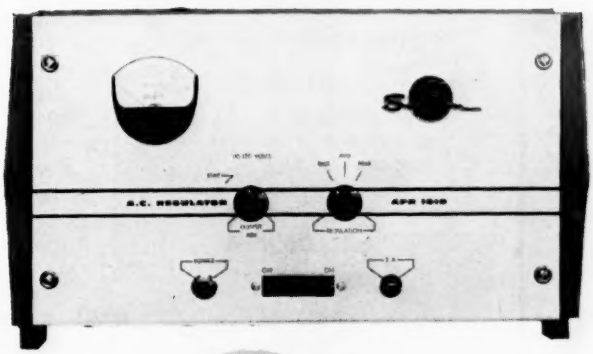
- ***FIVE* PRINCIPAL SENSING ARRANGEMENTS**

1. INTERNAL 2. EXTERNAL 3. REMOTE 4. CONSTANT CURRENT 5. DC

ELECTRICAL CHARACTERISTICS:

Input	**95-130 VAC, 1ϕ (50 or 60 cps ±10%)**
Output	**115 VAC, adj. 110-120V**
Regulation accuracy (RMS, average, or peak, switch selected)	**±0.1% against line** **±0.1% against load**
Distortion	**3% max.**
Load	**0-1000VA**
P.F. range	**Unity to 0.7 lagging**
Recovery time	**O.1 sec.**

Write for complete technical data.



SORENSEN & COMPANY, INC. Sorensen **STAMFORD • CONN.**

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment.

For more information circle **15** on inquiry card.

DIFFERENTIAL SWITCH

senses pressure differences from .45 to 45 inches of water

Used in hopper level indicating, on oil burner blower safety control, in instrumentation or similar applications where it is necessary to sense a pressure difference of .45 to 45 inches of water between a variable and a reference pressure. The reference pressure may be as high as 30 P.S.I.

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

Ask for bulletin 227

BARKSDALE VALVES

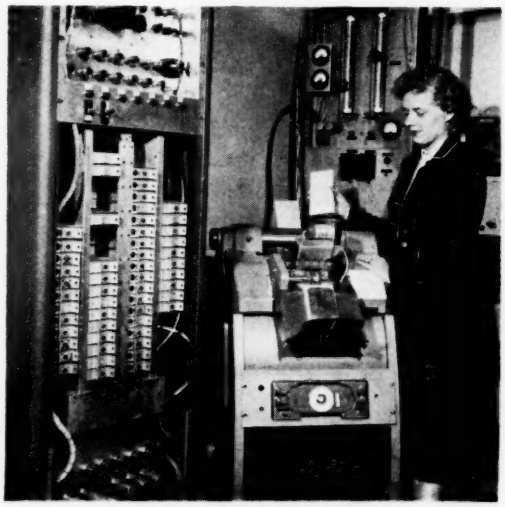
PRESSURE SWITCH DIVISION

5125 Alcoa Avenue, Los Angeles 58, California

For more information circle **16** on inquiry card.

Punched-Card Transcriber

WASHINGTON, D. C.—A punched-card transcriber developed by the National Bureau of Standards makes possible more rapid feeding of data into an automatic computer. The device converts numbers and instructions



recorded on punched cards into a binary serial code for direct rapid input into the computer or temporary storage as a magnetic recording. The system is about 150 times faster than the present paper-tape inscriber, and can handle up to 600 cards per minute. Intended primarily for use with the Bureau's high-speed electronic computer, SEAC, the transcriber serially scans the 80 columns on each card with photoelectric cells and converts the data, one column at a time, into a 4-or 6-digit binary code.

New RETMA Standards

NEW YORK, N. Y.—Four new recommended standards are listed below:

RS-159—*Chasis Pickup of Vehicular Receivers* (This standard, from Standards Proposal No. 499, is a reaffirmation of REC-111)

RS-177—*Vibrator Power Transformers* (This standard, from Standards Proposal No. 509, is a reaffirmation of REC-119)

RS-178—*Solderability Test Standard* (This Standard, from Standards Proposal No. 503, is new material)

RS-179—*Classification of Tube Testers* (This Standard, from Standards Proposal No. 506, is new material)

Carbon Tet Deadlier Than CO

PITTSBURGH, PA.—A recent article in *McCalls* magazine deserves to be brought to everybody's attention: The vapors emitted by carbon tetrachloride are four times as dangerous as carbon monoxide and twice as toxic as chloroform! Vapors from a cupful of CCl_4 in a poorly ventilated room may be deadly. Damage can be

how big can a small valve be?

Take this Hoke needle valve for instance...It looks pretty small on the front panel of Perkin-Elmer's new vapor fractometer, but it looks *big* in the eyes of the man who's buying or making equipment like this. Just a handful of brass? That's so, but carefully fashioned to control up to 3000 psi with no strain! It's added evidence of careful engineering.

Whether you're the man who makes high quality test equipment or the man who uses it, we'd like to prove to you how *big* Hoke valves can be. There are valves in the Hoke line for hydraulic and pneumatic equipment; for instrument panel or test stand use; for pilot plants . . . Forged needle valves (like the one shown), bar stock valves, packless valves and toggle valves. May we send you a catalog?

HOKE, INCORPORATED, FLUID SPECIALISTS, 231 S. DEAN ST., ENGLEWOOD, N. J.

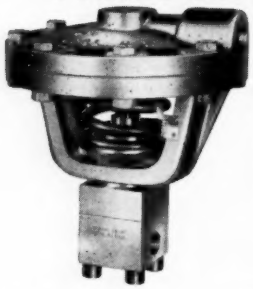
See us at
DESIGN ENG. SHOW
N.Y. Coliseum, May 20-23

HOKE

For more information circle **17** on inquiry card.

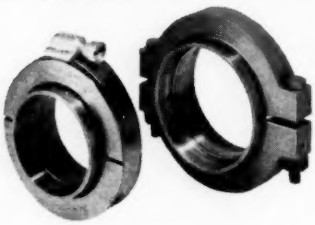
MINIATURIZATION

From Pilot Plant to Process



"BANTAM" 500 SERIES

Throttling "Bantam" Diaphragm Control Valves for all standard control valve uses, Cv of 0.6 and below, up to 1000 psi and 500°F, characterized, renewable trim, 316 stainless steel and teflon only wetted surfaces, low in hysteresis, size and weight, a modern design of control valve. 2000 series "Bantam" Control Valves available for on-off service.

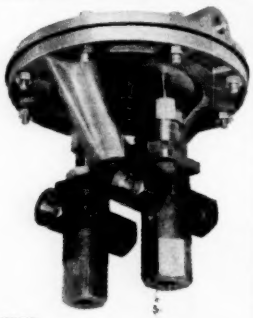


TUBE AND PIPE CONNECTORS

For use in such systems as aircraft or marine applications where weight is a factor, these connectors replace standard flanges. Available in various materials, in male or female socket or butt weld design, for tubing, and up to schedule 40 pipe.

"DEMI" PACKLESS VALVES

For services when packing is a problem, manifolding of small valves in one unit, these low cost valves have a great popularity. For services up to 1500 psi and 500°F., screw, toggle, or diaphragm operated, the "Demi" line is ideal for panel mounting up to five valves in one block.



WHIFFLETREE OPERATOR

Two valves operated simultaneously by one operator. Valves may be globe or three-way and have a multitude of piping arrangements for mixing and routing applications.

MANUAL RESET

Wherever control air on dangerous or toxic process flows must be blocked for safety, on air failure until manually reset, these valves insure against disaster. Standard sizes ¼" and ½" I.P.S.

SAUNDERS VALVES — AIR OPERATED

Plastic valves, 2" and below, metal valves 1" and below, G. W. Dahl Company, Inc. diaphragm operators on these valves provide simple, sure automatic operation. Each application must submit full flow information.

Write us for complete technical information, or the address of our representative in your area.

George W. DAHL Company

BRISTOL, RHODE ISLAND

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NEWS—CONTINUED

done not only by inhaling (even repeated small doses), but also by absorption through the skin—contact of the fluid with any flame or a heated body can produce phosgene gas. The fumes affect most seriously heavy drinkers, people with over-or-under weight, and sufferers of liver, lung, heart and kidney aliments.

If you have to use this silent killer (as instrument, radio, and TV repairmen often do) vent your room carefully, and dispose of rags outdoors.

News from the Atom Orbit

● At the 1957 *Nuclear Congress,* recently held in Philadelphia, eventual mass-production of nuclear research reactors reached a new stage with the reading of a paper describing a standardized control mechanism. Most of the 200 reactors of all types built so far have a control mechanism of individual design, while all of them must incorporate the same operating and safety principles. The ASME-sponsored paper proposes an electro-mechanical control-rod-drive mechanism consisting of standardized components which can be combined in various ways to fit the requirements of many types of reactors.

● The Congress also heard description of a new compact, lightweight, closed-cycle gas-cooled nuclear power plant suitable especially for ships. The unit, in the construction stage at the AEC's National Testing Station, may have an efficiency as high as 40%.

● *Aerojet-General Nucleonics,* which successfully built a portable low-cost nuclear reactor and then operated its mass-produced version (AGN201) at the Philadelphia Atomic Exposition held in conjunction with the Congress, received permission to build 3 additional units. With sixteen applications pending, a total of 21 reactors of the AGN201-type are thus completed or planned. Shipment of the entire reactor system (weighing 15,420 lb) was made by truck to Philadelphia, while the fissionable core assembly was flown to its destination on a routine passenger flight.

● Two new particle accelerators were displayed at the Exposition by *High Voltage Engineering Corp.*: (1) a 10-million-volt Van de Graaff "Tandem Accelerator" which will be installed at the Canadian Chalk River facility, and (2) a microwave linear accelerator operating in the area between 6 and 14 MeV.

● Proposed issuance by the AEC of a license to export a one-megawatt pool-type research reactor to West Germany's research facility at Technische Hochschule in Munich marks a new high point of cooperation.

● Officials of *Hooker Electrochemical Co.* shown in illustration, hold 2.8 pounds of the isotope boron-10,

Circle **19** on inquiry card. ⟶

solve many difficult control problems...use

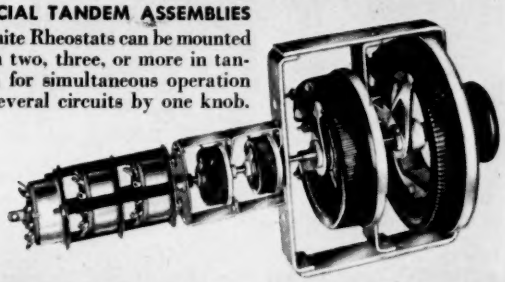
OHMITE®

RHEOSTATS

with special features

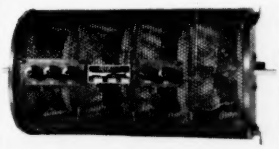
Ohmite offers not only a line of *standard* rheostats but also rheostats with a wide variety of *special features.* Illustrated are only a few. All have the distinctive Ohmite design features: smoothly gliding metal-graphite brush; all-ceramic construction; insulated shaft and mounting; windings permanently locked in place by vitreous enamel. You will find the special rheostat feature you need in the dependable Ohmite line.

SPECIAL TANDEM ASSEMBLIES
Ohmite Rheostats can be mounted with two, three, or more in tandem for simultaneous operation of several circuits by one knob.



BUSHINGS FOR SPECIAL THICKNESS
Extra-long bushings and shafts for panels up to 2" in thickness. Seven bushing lengths.

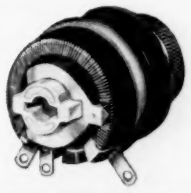
SCREW DRIVER SLOT SHAFT
Shaft ends slotted for operation with a screw driver where few adjustments are needed.



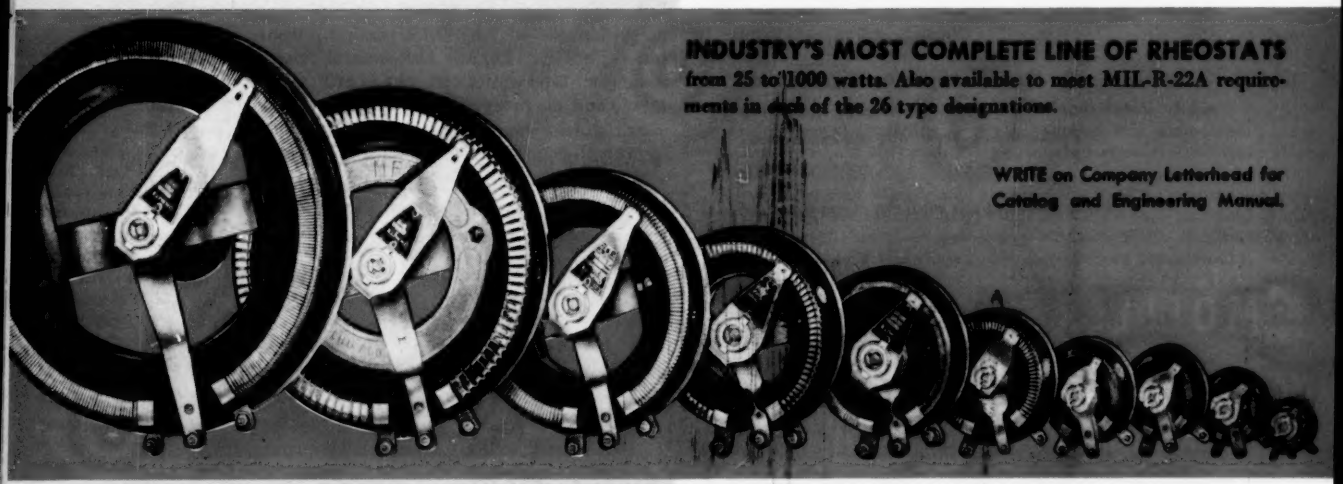
VENTILATED CAGES
Prevents mechanical injury to rheostat or human contact with electrically "live" parts.

SENSITIVE SWITCH
Opens or closes circuit with minimum movement of control knob shaft. Extremely dependable long life switches.

TOGGLE SWITCH
Is operated with a positive snap by the rheostat arm at either end position. Used for heavy-duty applications.



WITH OFF POSITION FEATURES
Opens circuit at high or low resistance position with *snap-action* (illus.); opens circuit at high resistance position with *dead lug* off position; or has *dead section* off position.



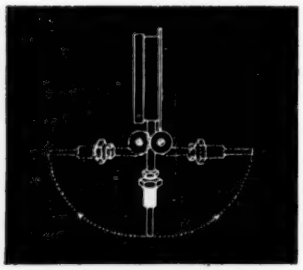
INDUSTRY'S MOST COMPLETE LINE OF RHEOSTATS
from 25 to 1000 watts. Also available to meet MIL-R-22A requirements in each of the 26 type designations.

WRITE on Company Letterhead for Catalog and Engineering Manual.

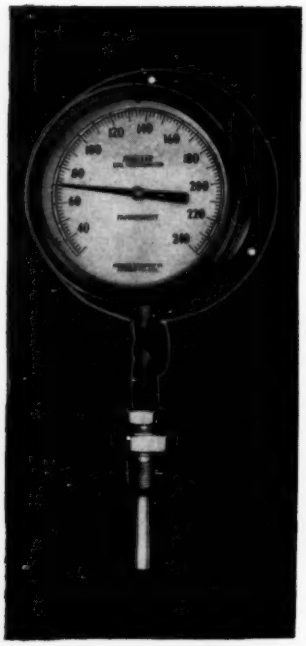
RHEOSTATS • RESISTORS • RELAYS
TAP SWITCHES • TANTALUM CAPACITORS

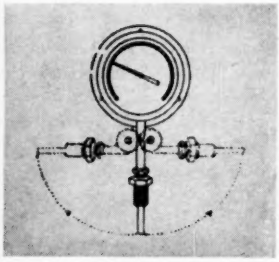
BE RIGHT WITH **OHMITE®**

OHMITE MANUFACTURING COMPANY, 3615 Howard Street, Skokie, Illinois



You get dependability PLUS with Moeller dial indicating (mercury actuated) thermometers





because—since 1867 our business has been the design and manufacture of temperature measuring instruments.

Up or down—left or right, you can easily install Moeller adjustable form dial indicating thermometers at any advantageous reading angle.

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Gentlemen: Without obligation, please send me Moeller Catalog No. 150 on Dial Indicating Thermometers.

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For more information circle **20** on inquiry card.

dubbed "gray gold dust" (valued at nearly three times the price of refined gold). This is one day's average production at the unique Hooker-operated AEC plant at Model City, N. Y. Boron-10 is now available for various civilian uses as an exceptionally efficient thermal neutron absorber and shield against atomic radiation.

• *Union Carbide and Carbon* has plans for the construction of a nuclear research center in Sterling Forest, 40 miles from New York City, to be built by AMF Atomics as a modified version of the Bulk Shield Testing Facility pioneered by Oak Ridge National Lab.

• *Leeds & Northrup* will supply the complete control and instrumentation system for the heavy-water-moderated nuclear reactor being built for MIT by ACF industries.

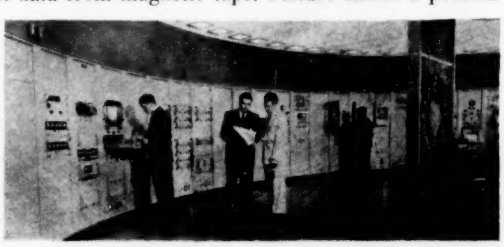
New Data Handling Centers

LOS ANGELES, CALIF.—*Beckman Instruments* dedicated its new Computation Center in February with the West-Coast unveiling of the EASE 1100 Series computer. The Center is under management of George A. Bekey, senior engineer. It will be available to business,

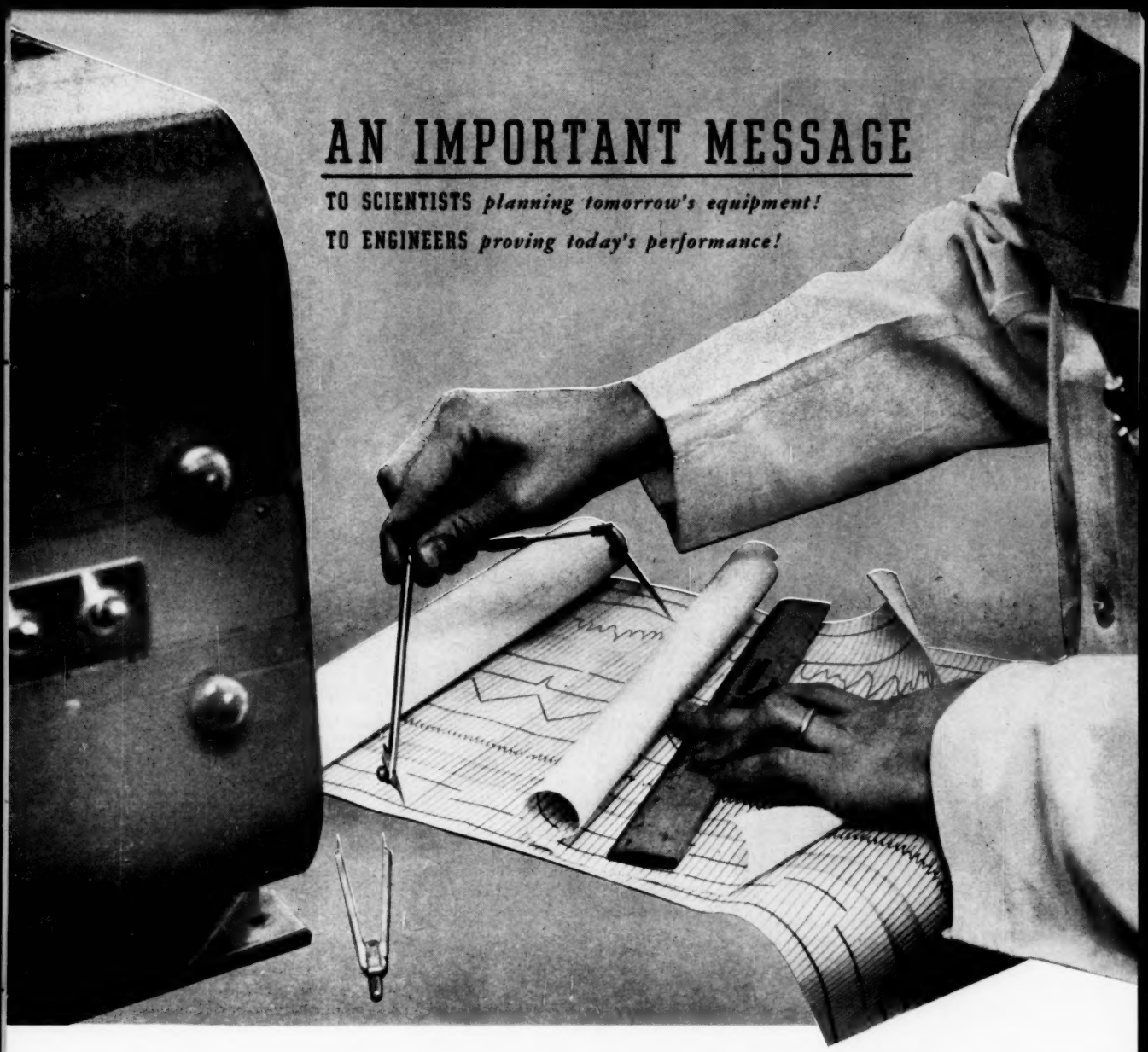
industry and educational institutions for solution of complex problems relating to aircraft, jet engines, guided missiles and industrial processes.

• *Bendix Aviation* has opened a Digital Computation Laboratory under the direction of Tak Yamashita. Equipment consists of two G-15 general-purpose digital computers, a DA-1 Digital Differential Analyzer Accessory, magnetic tape units, punched-card input-output equipment, and an independent paper-tape preparation unit.

• *Ramo-Wooldridge* has built a new Data Reduction Center to accurately and quickly decipher telemetered test data from magnetic tape. Picture shows a portion of



the semicircular array of electronic equipment modules. In the left foreground is part of the graphic recording section, followed (to the right) by the demodulation sections, the central control panel, test equipment section, tape handling machines, and (far right) vibration analysis section.



AN IMPORTANT MESSAGE

TO SCIENTISTS ***planning tomorrow's equipment!***

TO ENGINEERS ***proving today's performance!***

● Now it is possible to surpass previous analog data reduction accuracy. Now it is possible to make *precise* oscillograms and *accurate* read-outs . . . and on present equipment. A major advance is unfolding in accurate data reduction . . . and with it possible automatic processing and automatic read-out.

Grant Linatrace *dimensionally-stable* recording papers add a new capacity for analog data reduction and computing. By calibrating transducers, amplifiers and oscillograph galvanometers, a higher electronic accuracy of data reproduction has been possible. Now, by using Grant Linatrace Waterproof paper, a major advance in the photographic accuracy is possible.

Do you know that ordinary photographic papers expand and shrink as much as a quarter of an inch across a ten-inch width due to wet processing or humidity changes? . . . by as much as *ten lines or more* on a Benson-Lehner read-out viewer when processed and read under the most carefully controlled conditions?

Now Grant's new, *dimensionally-stable* photographic paper for high-frequency recording sharply reduces this distortion . . . and does this without air conditioning or other expensive accessories to "control conditions"!

Grant Linatrace Waterproof papers make oscillograms which have *less than* five thousandths of an inch distortion in a ten-inch width! They are available in Regular and Medium High speeds, and in Extra Thin, Single Weight, and Double Weight paper stocks.

Furthermore, Grant Waterproof Papers have longer life, can be processed much faster and air-dried *immediately!*

If you are a scientist planning tomorrow's equipment — an engineer testing today's experimental models, or proving today's performance, you will want to know more about Grant Linatrace Waterproof Recording Papers.

Phone us today, or write on your company letterhead for a dimensionally-stable oscillogram. Also ask for Grant Catalog R. Grant Photo Products, Inc., 19000 Detroit Ave., Cleveland 7, Ohio. (Phone: ACademy 1-6800.)

SOLD ONLY THROUGH AUTHORIZED DISTRIBUTORS

GRANT PHOTO REPRODUCTION MATERIALS

SINCE 1906

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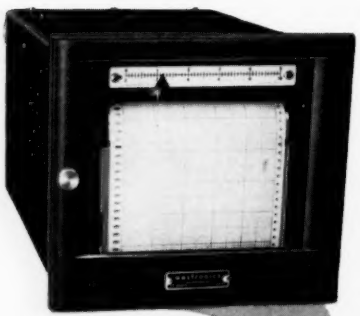
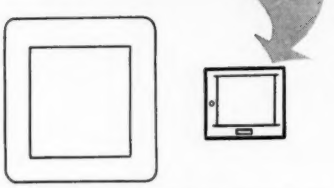
MINIATURE
RECORDING
POTENTIOMETER

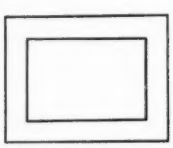
This revolutionary recorder saves you two ways . . . fits in a small space (only 9⅝ inches wide and 8½ inches tall) and costs less.



Model 2705



COMPARE THE SIZE



SPECIFICATIONS

- Null balance
- Pen speed: 1 second
- .5% accuracy
- TC or MV calibration (5MV to 100MV)
- Automatic continuous standardization
- Max source impedance 1000 ohms per MV of span
- .14% sensitivity

OPTIONAL FEATURES

- 3 speed chart drive transmission
- 1 to 4 SPDT adjustable control switches
- Reference junction compensation
- Selsyn motor chart drive
- Transmitting slidewire
- Event marking margin pens

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Science on TV

Dr. Martin L. Klein and program guest Diane Weber, Hollywood starlet, who appeared on 3-D telecast of ADVENTURE . . . TOMORROW. Diane played table tennis with the viewers in 3-D and shot arrows and drove golf balls into the viewer's room.

LOS ANGELES, CALIF.—One of the axioms of television used to be that science programs never have a large audience. This axiom, however, has been made obsolete since April of last year.

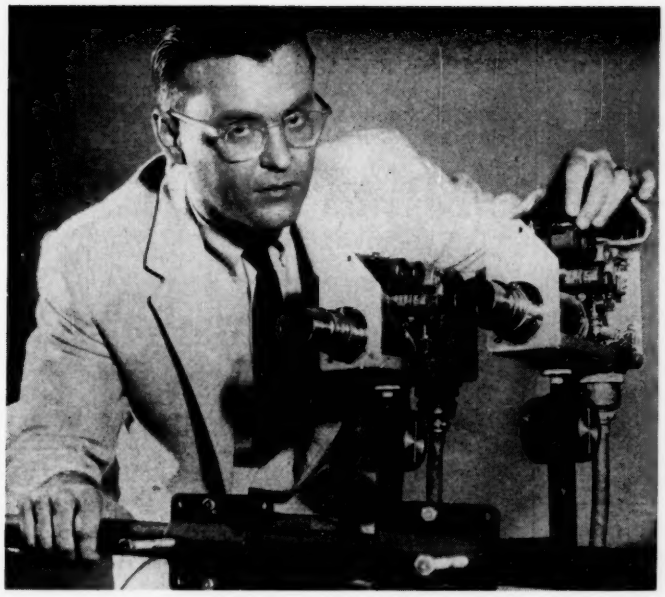
ABC Television in Los Angeles set out to prove this with a program called ADVENTURE . . . TOMORROW. Today, it is the highest rated science program on television. It now has sponsors in eight cities. In fact station KABC thought enough of the program to place it in the slot immediately preceding its highest rated program on television, "The Lawrence Welk Show."

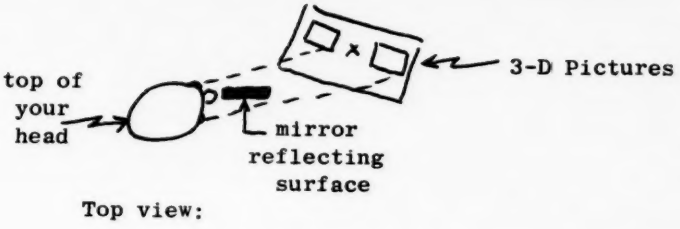
ADVENTURE . . . TOMORROW is a science program which gives scientists an opportunity to meet the public and explain what they are doing. But instead of just talking about their work, they show motion pictures of the actual operation. Every week, the program is assembled by two engineers, Harry C. Morgan and Dr. Martin L. Klein. Klein acts as mc and the weekly "live show" is filmed for distribution throughout the world.

In order to keep the subject matter within the understanding of the audience, various simple devices are used. For example, on a program planned to demonstrate what an electronic digital computer can do, the unit was brought into the studio and it competed, answering questions on sports, against a panel of the sportswriters of the leading Los Angeles newspapers. The sportswriters beat the machine in picking the top money-winning horses of all times, but the machine beat the experts on three other questions. On another program about computers, DATATRON was programmed to write popular music and the results were performed by nationally known songwriter Jack Owens.

Programs on rockets are in the greatest demand. There have been twelve programs showing what rockets do and how they work. The standing guest expert on rocket engines is Dieter Huzel of Rocketdyne. In fact, Huzel was on the program so many times that he was compelled to get a professional-entertainer's union card, which adds to his distinctions as a world famous rocket engineer. Klein figures he has launched more rockets (via film) than any other single agency in the world.

One of the favorite programs of the viewers concerned flight testing of the Bell X-1A rocket plane. Col. Chuck Yeager was brought in from





The first commercial 3-D telecast in history was made on February 2. A repeat program was done on March 2. The equipment was built by Kintel Corporation of San Diego California (formerly Kay-Lab Corporation). It is useful either in closed circuit or broadcast applications. The right camera and left camera are used simultaneously, both focused on the same subject. The scan is electronically split, half the screen being filled with each camera. The right camera scan is reversed. To view in 3-D, the viewer holds a pocket mirror up to his nose, lengthwise, and superimposes the images (the mirror re-reversing the right image).

Germany by the United States Air Force to explain what he was doing as the program showed step by step an over-the-shoulder view of the drop from the mother plane and the build-up to 1700-miles-an-hour flying speed.

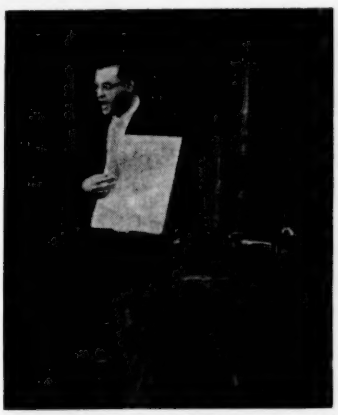
Once a year, in collaboration with the Institute of Radio Engineers, all of the most intriguing electronic inventions of the best twelve months are demonstrated. On one program—"One for the Girls"—all of the inventions of direct interest to women were shown: UHF electronic cooking ranges, electronic organs, an automatic bar, the television telephone. In less than three days 7000 requests for further information were received.

Companies pay a premium price for the opportunity to sponsor the program. But the most gratifying part of the work, according to Klein, is the interest displayed by young people. In Los Angeles, the largest competing program is "The Lone Ranger" and many of the Lone Ranger's fans now find it more exciting to ride through space than across the plains.

In February, ADVENTURE . . . TOMORROW had another television first. It televised in 3-D, but no special receivers or glasses were required to view it in 3-D.

Dr. Klein and Harry Morgan are well known to readers of *I&A*, as authors of the Digital Automation series.

Fission, Fusion, Finis. In a program on the effects of atomic energy, Adventure . . . Tomorrow showed the principle of fission and the end result . . . Hiroshima. Klein is demonstrating natural radioactivity with a Geiger Counter.

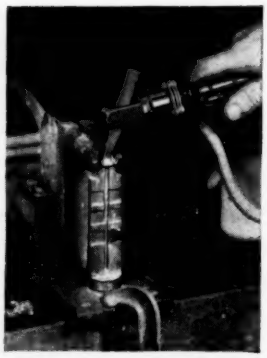


In a program called "I spy on Hi-Fi", the station transmitted various frequencies allowing viewers to check their sets. Here Klein is showing what the vacuum tube does in a hi-fi set. Many viewers claimed they could hear a 15,000 cps tone. The station cannot transmit a tone this high.

On a program called "Electronics Tomorrow", Klein promised to build a radio in five minutes. He is shown explaining the parts that go into the radio, a transistorized version. He didn't make it. It took six minutes and forty seconds.

Resistance Heat Soldering Ends "Cold Flow" Rejects-- Insures Strong, Uniform Joints

In an increasing number of plants, resistance heat soldering has practically licked the problem of non-uniform solder joints and "solder voids."



Resistance heat soldering of parts with preformed soldering rings, using "Pencil" attachment, and jig set-up.

The resistance heating principle makes cold flow joints all but impossible. High amperage, low voltage current, passing *through* the joint to be soldered, heats the joint above the temperature required to melt the solder. Heat is concentrated at the point of contact to prevent burning of nearby parts. No set-up or pre-heating is necessary. Solder adheres instantly and uniformly over and between the surfaces to be joined, to make the strongest joint it is possible to make. Heat is adjustable by thumb switch and instantly controlled to meet job requirements.

For the Most Complete Information Available on Resistance Heat Soldering, Send for Data on

IDEAL THERMO-GRIP SOLDERING SETS

Used for more resistance heat soldering than any other type. Complete details on all models, from the 450-watt light duty model up to the 7500-watt unit for large brazing jobs. Also application data on various attachments, including "grip-and-heat" "Pliers", "Fork" and "Pencil" attachments. All units are fully portable.

PROVED BETTER FOR JOBS LIKE THESE:

- Hermetic closures
- Tube joints
- Bellows and diaphragms
- Bourdon tubes
- Wherever strong, vibration-proof or air-tight seals are required.

SOLD THROUGH AMERICA'S LEADING DISTRIBUTORS
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GET FULL DATA FREE

IDEAL INDUSTRIES, Inc.
1420-D Park Avenue, Sycamore, Illinois

Please send full information and technical data on IDEAL Thermo-Grip Soldering and Brazing Equipment.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

For more information circle **23** on inquiry card.

News Bits

IBM's 305 RAMAC and 650 RAMAC business accounting machines which were marketed first last September have proved to be in great demand. The company reports sales of 1000 systems in five months.

UNION SWITCH & SIGNAL received an order for designing and installing signaling apparatus for New York's Broadway-Seventh Avenue subway. This modernization of the system will cost the city nearly 9½ million dollars.

UNDERWOOD CORP. has been holding a series of 2½-day invitation-seminars for executives in various major cities of the country. Their purpose is to explain the potentialities of the company's new medium-scale computer, the Elecom 125.

TELEREGISTER CORP. is expanding Pan American World Airways' reservation system (now in operation in Long Island City) to make it the first coast-to-coast automatic reservations set-up capable of handling 3600 inquiries per hour. A similar system will be installed next year for Western Air Lines' ticket agents at 73 locations, with headquarters in Los Angeles.

Stock Report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

New York Stock Exchange:

	Price Range for 1956-57 Thru March 19th		
	High	Low	Price As Of March 19, 1957
ACF Industries	67 7/8	55	61
Aeroquip Corp.	25 3/4	11 7/8	24 7/8
Allis Chalmers	37 1/4	30 1/8	32 5/8
American Chain & Cable	61 3/8	38 1/2	51
American Machine & Foundry	40 3/4	24 1/8	36 1/4
American Machine & Metals	47 3/4	35 1/8	47 3/4
American Optical	40 3/4	33	33 7/8
American Tel. & Tel.	187 1/8	165	177 1/2
Beckman Instruments	43 1/8	25 1/8	40
Bell & Howell	50 7/8	28 1/4	41
Bendix Aviation	64 3/8	48 1/2	58 3/4
Boeing Airplane	65 3/8	45	47 1/8
Bullard	38 3/8	22	24 5/8
Bulova Watch	23	20 1/8	20 1/4
Burroughs	46 7/8	28 1/2	39
Carborundum	45 5/8	31 1/2	41 3/4
Cincinnati Milling Machine	55 1/4	37 1/4	42 1/8
Clevite	24 1/4	18	19 3/8
Columbia Broadcasting 'A'	34 1/2	22 5/8	32 1/2
Consolidated Electronics	36 1/2	26 1/2	42 5/8
Cornell Dubilier	40 1/8	21 5/8	23 1/4
Corning Glass	87 1/2	57 1/4	68
Curtiss-Wright	49 3/4	26 3/4	41 5/8
Cutler Hammer	65	53	55 3/4
Daystrom	34 1/4	22	32 7/8
Dobeckmun	39 1/4	24 1/2	26 1/4
Douglas Aircraft	95 5/8	72 1/2	76 3/8
Eastman Kodak	100 3/4	75 3/4	85 1/2
Eaton Manufacturing	66	51 1/2	58 1/4
Electric Auto Lite	41 3/8	30 1/4	37 3/8
Elgin Watch	17 3/8	11	12
Food Machinery & Chemical	77	51	59 5/8
Gamewell	36 1/2	25 5/8	32
Garrett	54 1/2	38	47 3/8
General Dynamics	61 5/8	45 1/8	59 3/8
General Electric	65 1/2	52 3/8	56 1/2
General Instrument	10 1/8	6 1/4	6 5/8
General Mills	71 3/4	59 3/4	61
General Precision Equipment	53 1/2	34 1/2	39 1/8
General Railway Signal	34	27	31 3/8
General Telephone	46	38	42 1/8
General Time	34 5/8	28 1/4	28 3/4 - 29 1/2(a)
General Tire & Rubber	72 1/2	47 1/4	68 3/8
Goodyear Tire & Rubber	84	60	75 1/2
Hamilton Watch	28 1/4	19	24 5/8-25 1/4(a)
Hoffman Electronics	25 3/8	17 3/8	18 3/8-
International Business Machines	550	400	515
International Tel. & Tel.	37 3/8	29 1/4	32 1/2
Lockheed Aircraft	58 7/8	43 1/4	45 1/4

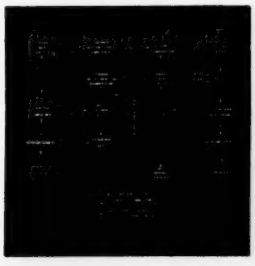
Continued on page 614

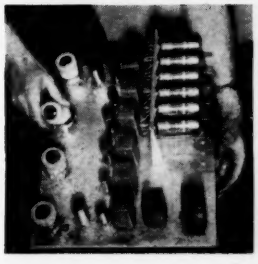
THE KYBERNETES CORPORATION

Division of Self Winding Clock Company, Inc.
for 70 years leader in time standards
and precision engineering

ALL ELECTRONIC LINE OF AUTOMATIC DATA PROCESS LOGGERS

A revolutionary engineering concept, the Kybernetes Electronic Data Logger puts to use designs largely predicated upon advanced techniques developed by the computer industries, featuring reliability and accuracy.





KYBERNETES®

Write for Bulletin '108'

THE KYBERNETES CORPORATION

Executive Offices:
9 East 40th Street
New York 16, N. Y.
MUrray Hill 3-6030

For more information circle **24** on inquiry card.

AUTOMATIC PRESSURE or VACUUM CONTROL J6

UE TYPE J6 PRESSURE & VACUUM CONTROL

UNITED ELECTRIC TYPE J6 unit is designed to automatically control either pressure or vacuum . . . has a fixed, uniform on-off differential as specified between limits of 3" WC to 2 PSI . . . and a maximum controlling pressure of 180 PSI. It is a sensitive, weatherproof, precision built control with good repeatability. Recommended for all pressure or vacuum applications which require close on-off differential control.

Switch Differential	Fixed as specified between limits of 3" WC to 2 PSI.
Switch Ratings	15 or 20 amps at 115 or 230 volts AC, also DC switches upon specification.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Size	4¾" x 4 27/32" x 2 5/16".
Weight	Approx. 1 lb. 8 oz.
Electrical Connection	½" NPT conduit opening in enclosure, screw type terminals on switch is standard.
Enclosure	Die-cast aluminum case, black wrinkle finish standard.
Mounting	Surface mounted—by 2 mounting ears.
Bellows	Seamless brass—spring loaded.
Pressure Connection	¼" NPT female connection.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. UE will gladly modify or custom-build a unit to your specifications. Consult a UE application engineer today.*

Write for Bulletin No. 5-3 for complete J6 data.

United Electric Controls COMPANY
83 SCHOOL STREET WATERTOWN MASS

For more information circle **25** on inquiry card.

New York Stock Exchange:

Continued from page 612

Magnavox	41	31 1/2	35 1/2
Minneapolis-Honeywell	90 1/2	58	81 3/4
Minnesota Mining & Manufacturing	75 1/2	58	64 3/4
Motorola	51 3/4	35 3/4	41 1/2
National Acme	82	62	70 1/4-70 1/2(a)
National Cash Register	59	34 1/2	54 1/8
North American Aviation	49 7/8	27 1/2	30 3/8
Northrop	29 1/8	21 1/4	26 1/2
Otis Elevator	50 3/4	33 1/4	42 7/8
Philco	36 1/2	14 1/8	14 7/8
Radio Corp. of America	50 3/8	31 5/8	33 1/8
Raytheon	20 7/8	13	17 1/2
Rheem Manufacturing	37 1/8	17 3/8	18 1/8
Robertshaw Fulton	29 1/4	21 1/2	29
Sangamo Electric	37 1/2	29 1/2	31 3/4
Sperry Rand	29 1/8	20	20 7/8
Square D	32 7/8	22 5/8	30 1/4
Standard Coil Products	12 3/4	6 1/4	8 3/8
Starrett (L.S.)	73 3/4	43 3/4	65 1/2-67 (a)
Stewart-Warner	39 1/2	30 1/4	37 3/4
Sylvania Electric	55 7/8	39 5/8	41 3/4
Telautograph	15 1/4	6 3/8	7 1/4
Texas Instruments	18 3/8	11 5/8	17 3/8
Thompson Products	80	48 3/8	76 1/2
Tung-Sol Electric	36 3/8	27	29 1/4
Underwood Corp.	44	20 7/8	28 1/4
Union Carbide & Carbon	133 3/8	100 5/8	110
Western Union	22 1/2	17 1/2	18 3/4
Westinghouse Air Brake	36 3/8	26 1/2	29 1/2
Westinghouse Electric	65 7/8	50 7/8	55 3/8
Worthington Corp.	60 1/2	41 1/8	55 1/4

American Stock Exchange:

	Price Range for 1956-57 Thru March 19th		Price As Of March 19, 1957
	High	Low	
Air Associates	13 1/2	8	8 3/8
American Meter	41	31 1/2	32 3/4-33 1/2(a)
Arc Equipment	24	17 1/4	18 5/8
Belock Instrument	19 3/8	11	10 5/8-11 (a)
Benrus Watch	10 3/8	6 7/8	7
Breeze Corp.	9 1/8	5 3/4	7
Clark Controller	37	16 1/4	27 5/8-28 1/4(a)
Clarostat Mfg.	5	3 1/8	3 1/2-3 3/4(a)
Clary Corp.	6 7/8	4 1/4	4 3/4
Consolidated Electrodynamics	40	21	36 1/2
DuMont Laboratories	10	4 3/8	4 3/4
Dynamics Corp. of America	8 3/8	5 5/8	6 3/8
Electronics Corp. of America	24 1/4	9 5/8	10 1/2-11 (a)
El-Tronics	9 7/8	2 7/8	3 1/2
Fairchild Camera & Instrument	25 7/8	16 1/8	17-17 1/4(a)
Globe-Union	22	16 5/8	20
Haseltine Corp.	48	30 1/2	34
International Resistance	8 1/4	4 1/2	5 1/8
Lear Inc.	10 1/4	7 1/4	7 5/8
Litton Industries	40	23	39 7/8
National Research	29 3/4	16 1/4	21
Neptune Meter	36	28	28 1/2-29(a)
New Haven Clock	2 1/2	1/4	1/4
Norden-Ketay	14 7/8	7 3/8	9 3/8
Nuclear Corp. of Amer. 'A'	2 1/2	3/4	1 5/8
Pneumatic Scale	28 1/4	23 3/4	23 1/2-24 1/2(a)
Reliance Electric	42	36	41 7/8
Servo Corp. of America	7 3/4	4 5/8	5-5 1/8(a)
Servomechanisms	13 1/2	8 1/4	10-10 1/4(a)
United Shoe Machinery	61 5/8	40 1/2	42 7/8
Wallace & Tiernan	32 1/2	19 1/2	27 1/2
Waltham Watch	3	1 1/4	1 7/8

OVER-THE-COUNTER

	March 19, 1957	
	Bid	Asked
Aerovox Corp.	4	4 1/2
Aircraft Radio Corp.	17	19
Argus Corp.	16	17
Barry Controls, Inc. (March 14th)	10 1/4	11 1/4
Eitel-McCullough Co.	34	36
Electronics Associates	71	75
Elox Corp. of Michigan 'A'	8 7/8	9 1/2
Elox Corp. of Michigan 'B'	8 3/4	9 1/4
Erie Resistor Corp.	19 3/4	20 3/4
G. M. Giannini	14 1/8	14 3/4
I-T-E Circuit Breaker	34 3/4	35 1/2
Liquidometer Corp.	8	8 3/4
P. R. Mallory & Co.	46 1/2	47 3/4
W. L. Maxson	7 1/4	7 3/4
Penn Controls, Inc.	18	19 1/2
Speer Carbon, Inc.	30 1/2	31 1/2
Sprague Electric	32 1/4	33 1/2
Taylor Instrument	69 1/2	71
Telecomputing Corp.	3 7/8	4 1/4
Topp Industries	8 5/8	9
Varian Associates	16	16 1/2
Vitro Corp. of America	18 1/4	18 3/4

(a) Bid and Asked prices

Emery NEWS

WEIGHING SYSTEM

BIN, TANK AND HOPPER EDITION No. 4

Covering design, development and application data on Emery Weighing Systems for industrial applications

EMERY LOAD CELLS TEAM UP WITH ALL TYPES OF INSTRUMENTATION TO BUILD EFFICIENT BIN AND TANK WEIGHING SYSTEMS

WHETHER THE FUNCTION BE INDICATION, RECORDING OR CONTROLLING, YOU CAN CHOOSE INSTRUMENTS OF PRACTICALLY ANY MANUFACTURER TO WORK EFFECTIVELY WITH EMERY LOAD CELLS.

The inherent advantages of accuracy, simplicity, ruggedness, fast response and vibratory and cross loading, which accrue to the use of Emery Load Cells need not be sacrificed because of any instrumentation limitations.

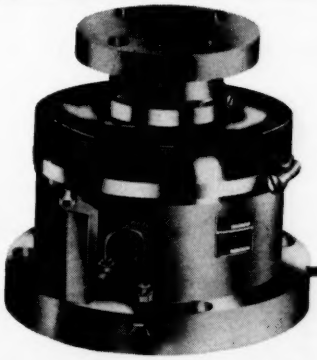
Practically every indicator, recorder or controlling instrument on the market today, whether hydraulically, electrically or pneumatically operated, can be used with the Emery Load Cell.

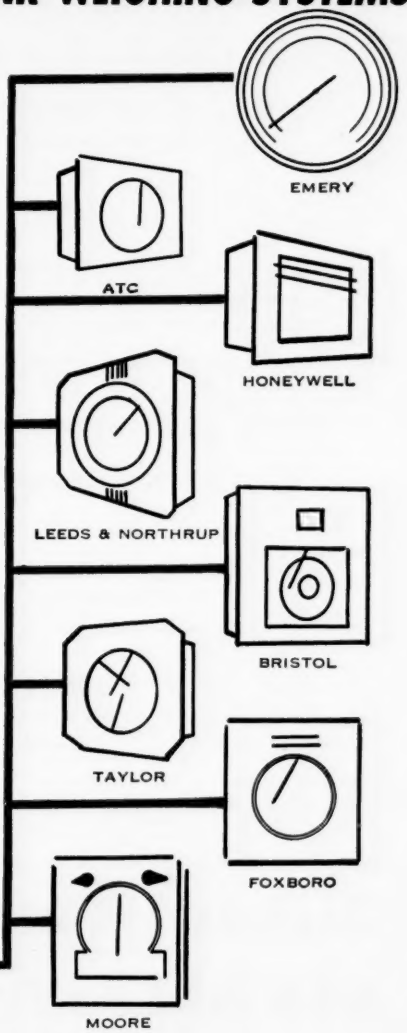
Emery Load Cells, calibrated at our factory to an accuracy of better than .1% of load range, are manufactured to withstand the rough conditions of rugged industrial use and yet give long, accurate service life.

Nor can any engineer overlook the important design advantage of the "rolling ball" head in Emery Load Cells. Because of it, these cells can withstand substantial off-center loads as well as a reasonable amount of cross loading.

SEND FOR NEW BULLETIN

Our new Bulletin 561 shows 14 basic arrangements of Emery Load Cells in bin and tank weighing installations. Included is an important section on Instrumentation. If you have not received your copy yet, send for it today.





THE A. H. EMERY CO. PRECISION SINCE 1872 FORCE MEASUREMENT

THE A. H. EMERY COMPANY

Pine Street • New Canaan, Conn.

For more information circle **26** on inquiry card.

ATTENTION!

Sales Managers —

Exhibit space at the 4th INTERNATIONAL AUTOMATION EXPOSITION should sell-out in a hurry.

Plan now to budget time and money for 1958's biggest automation event.

Automation Congress, Conferences, and Clinics, associated with the Show, guarantee intensified local and overseas interest in this event.

WHEN—June 9-13, 1958

WHERE—New York Coliseum

For details, floor plans, etc., write

Richard Rimbach Associates, Exp. Mgmt.
845 Ridge Avenue, Pittsburgh 12, Pa.

NOW! CONTROLLABLE PERSISTENCE FOR TV AND RADAR

TONOTRON

Direct-display, cathode-ray storage tube by Hughes with magnetic deflection and electrostatic focusing

DIMENSIONS
Over-all length: 11 1/2" nominal
Bulb diameter: 5 1/4" ± 1/8"
Neck diameter: 1" ± 1/16"

FOR NARROW BAND, SLOW SCAN CLOSED CIRCUIT TV

Controllable long persistence makes the Tonotron ideally suited for picture transmission over conventional radio channels or telephone lines. Coaxial cables or microwave transmitters and receivers are unnecessary. Pictures up to 80 lines per inch resolution cover the full half-tone scale with controllable persistence—instantaneous or gradual erasure. Light output of 1000 foot-lamberts at 10 kv assures extremely high brightness at the viewing screen for use in high ambient-light levels.

FOR RADAR PPI DISPLAY

Because of the Tonotron's compact size, it can be used in many existing radar indicator housings. Brightness of 1000 foot-lamberts at 10 kv makes a viewing hood unnecessary, even in full daylight. Persistence can be adjusted to retain nearly maximum brightness throughout the major portion of a 360° sweep. Ability to cover the complete grey spectrum provides maximum contrast for easy identification of cloud formations, mountains, harbors and waterways, airports, ground clutter and targets.

ELECTRON TUBES

For additional information, write to HUGHES PRODUCTS • ELECTRON TUBES
International Airport Station, Los Angeles 45, California

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HUGHES PRODUCTS

For more information circle **28** on inquiry card.

New Plants and Mergers

New Westbury, Long Island plant of Servomechanisms, Inc.

The Annin Co. new plant, East Los Angeles, Calif.

HALOID CO. has given **TEXAS INSTRUMENTS INC.** a license to manufacture and market xerographic oscillograph machines.—The latter company's ultra-modern Dallas plant will house the Semiconductor-Components division.

EPSCO, INC. recently increased its floor space from 30,000 to 50,000 sq ft.

SERVOMECHANISMS, INC. will put up a new plant at Westbury, L. I.

THE ANNIN CO.'s new plant in the East Los Angeles industrial area is well under way.

BRANSON INSTRUMENTS recently moved into its new building in Stamford, Conn.

AUTOMATIC TEMPERATURE CONTROL CO. is preparing to move into a new plant at King of Prussia, Pa. in July or August.

ARNOUX CORP. recently occupied two newly completed buildings, adding 15,000 sq ft to existing plant facilities.

LOGISTICS RESEARCH announced change of the company name to **ALWAC CORP.** Simultaneously the company will occupy two new buildings totaling 70,000-sq-ft floor space.

BAKER & CO., one of the Engelhard Industries, has established a new instrument division, headed by vp D. L. Alexandre.

BECKMAN INSTRUMENTS, *Scientific Instruments Div.*, is adding a $1.5-million unit to house research and development; the *Berkeley Div.* in Richmond, Calif., will triple production and increase plant personnel by 1000 in a new 147,000-sq ft plant; the *Helipot Division's* $3-million plant, now under construction, will house also the newly acquired firm of *Lou-Bar Products;* and last but not least, it is announced that an agreement was reached between *Beckman Instruments* and *Statham Laboratories* to merge the two multi-million-dollar firms.

SIMPLEX EQUIPMENT CORP, has become a subsidiary of **GENERAL PRECISION LABORATORY.**

DAVIES LABORATORIES was acquired by **MINNEAPOLIS-HONEYWELL REGULATOR CO.** and will become a new Division of the parent company.

ALLEGANY INSTRUMENT CO. has opened a Western Division in Los Angeles which will be headed by James G. Ramsay.

I-L-S INSTRUMENT CORP. announces the opening of its new manufacturing and engineering facility in Cleveland.

A Superior Detector

for

Infra-Red Spectroscopy

GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
3. **Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.**
4. **Improved, drift-free, A.C. operated amplifier with step gain controls and four response periods.**

Write for EPLAB Bulletin No. 10

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

2 SHEFFIELD AVENUE, NEWPORT, RHODE ISLAND, U.S.A.

For more information circle **29** on inquiry card.

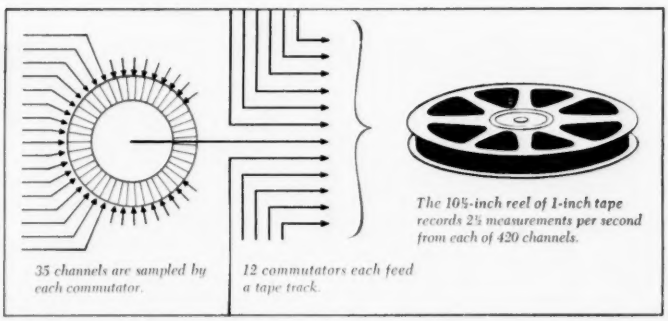
MAGNETIC TAPE APPLICATIONS BY AMPEX

2

How to record 420 channels of simultaneous data

Boeing Airplane Company's flight tests demonstrate an easy way

Have you ever seen an oscillograph record that was eight and a half feet wide? At fifty channels per foot this is what it would take . . . which shows the decided advantages in the way the Boeing Airplane Company solves the problem. They put 420 channels of data onto a one-inch magnetic tape. Two hours of flight test can be recorded on one 10½-inch reel.


35 channels are sampled by each commutator.
12 commutators each feed a tape track.
The 10½-inch reel of 1-inch tape records 2½ measurements per second from each of 420 channels.

In a published article, Mr. Arthur T. Snyder of Boeing describes their system as a low level, low-speed, pulse-width-modulation technique. It time-multiplexes 35 channels of data onto each of 12 tracks (of 14) on an Ampex 814 Airborne Magnetic Recorder; ($35 \times 12 = 420$). The system inputs are variable resistances, thermocouples, strain-gage bridges and other bridge-type transducers. Each is fed to a segment on one of twelve rotating commutators that sample every channel 2½ times per second. The Ampex 814 recorder running at 3¾ in/sec. records over 8-million measurements in two hours.

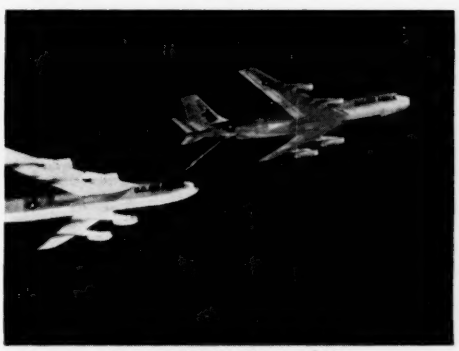
This recording system used by Boeing is limited *by choice* to data that changes at a slow rate. This is by no means a fixed limitation. Certain Ampex recorders (Series 800, FR-100 and FR-1100) have interchangeable amplifiers. Each track can thus be used with any one of three types of recording according to frequency requirements:

With PWM recording (like the Boeing example) as many as 88 channels of low-frequency data can be put onto one track.

With direct recording up to 18 channels of RDB subcarrier data of varying frequency requirements can go onto one track – or very high-frequency data uses one track per channel.

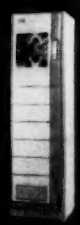
With FM carrier recording one channel of data occupies one track and provides high instantaneous amplitude accuracy. FM is particularly suitable for shock and vibration records.

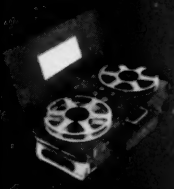
When a recording containing a large number of channels of data is reproduced, another of magnetic tape's advantages becomes apparent. The data can be reproduced in electrical form. Consequently it is a relatively simple matter to unscramble the channels by automatic or semi-automatic means. Any combination of channels can be scanned, correlated and fed to computing devices. These fortunate faculties of magnetic tape help reduce the handling of vast amounts of data down to a task of wieldy size. For example in the Boeing flight tests already mentioned, all data is published within two or three days after the test instead of from several weeks to several months later as by previous methods.

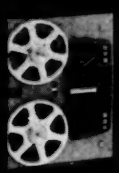


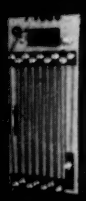
Boeing KC-135 tanker in flight.

If you have a specific problem involving large amounts of data or unusual combinations, Ampex's application engineers will be pleased to furnish further information. More of the capabilities of magnetic tape will be discussed in this continuing series of bulletins. Would you like to have copies mailed direct? If so, write Dept. ***BB-4***









INSTRUMENTATION DIVISION
AMPEX CORPORATION

FIRST IN MAGNETIC TAPE INSTRUMENTATION

934 CHARTER STREET • REDWOOD CITY, CALIFORNIA

District offices serving all areas of the United States and Canada; Foreign Representatives in countries around the world.

For more information circle **30** on inquiry card.

NEW

Data-Readout Counter

Provides 100,000 Distinct Circuit Arrangements

Electrically actuated data readout counter with electric reset. Form B-1538 for 110V AC/DC.

FUNCTIONS

Analog to Digital Conversion
Serial or Parallel Circuit Transmission
Continuous or On Demand Electrical Readout
Continuous Visual Readout
Visual and Electrical Data Storage
Predetermining
Repeat Predetermining
Sequential Programming

Veeder-Root's new series of Data Readout Counters combines visual indication with electrical readout for remote indication, recording, and controlling applications. *Electrically* or *mechanically* driven and provided with *manual* or *electric* reset, these counters present a positive display of accumulated totals and automatically create specific control circuit contact closures for each number visually displayed. Each instrument, with its five figure capacity, provides 100,000 distinct circuit arrangements which lend themselves to the most exacting control and transmission requirements. The counters are compatible with standard data processing equipment and offer a wide variety of applications in the industrial control and data processing fields.

Veeder-Root Inc.

"THE NAME THAT COUNTS"

Hartford, Conn. • Greenville, S. C. • Chicago • New York • Los Angeles
San Francisco • Montreal • *Offices and Agents in Principal Cities*

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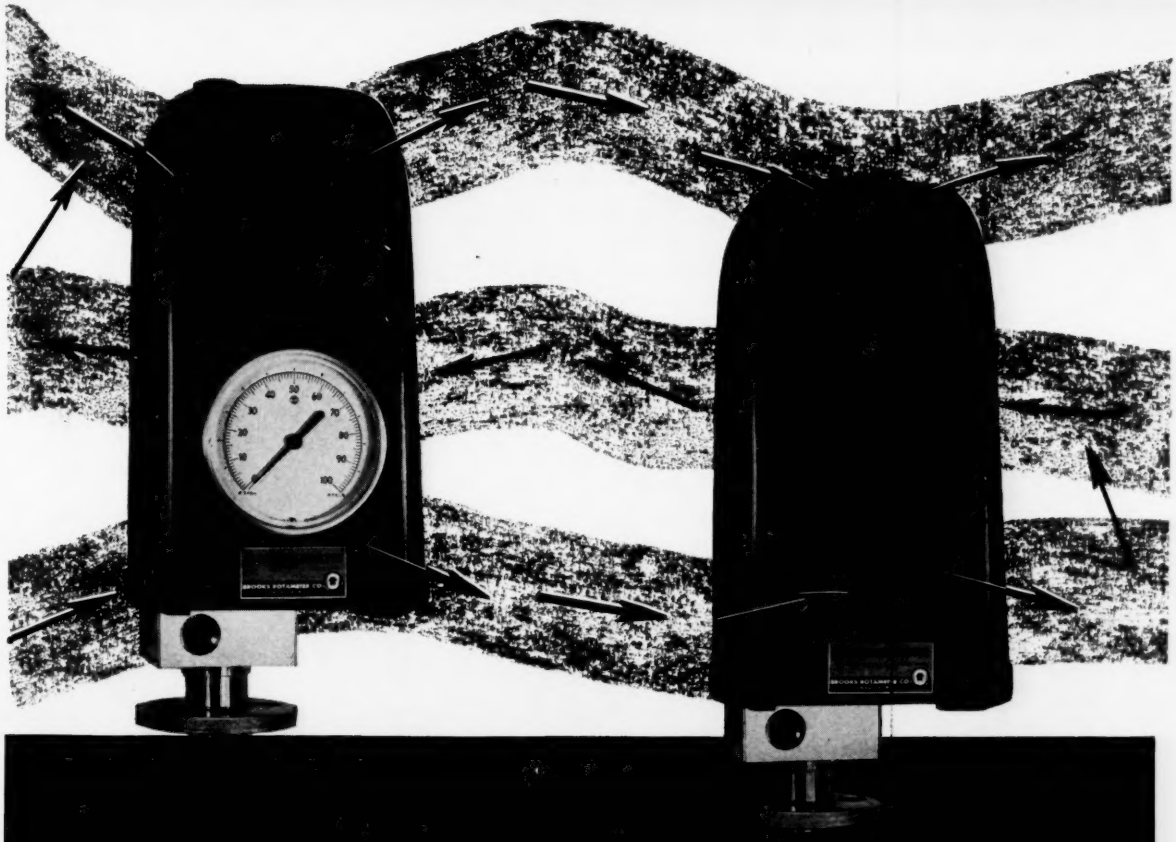


in remote flow transmission

are convertible... electric or pneumatic

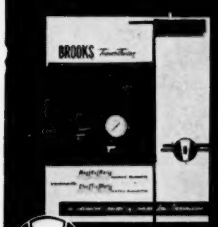
Never before such flexibility . . . such performance. The new Brooks *TransiTWINS* are one basic flow transmitter design in two forms; fulfilling your present *and* future requirements. The Mag Nu Matic is a force-balance pneumatic flow transmitter; the Elec Tru Matic is electrical. Now, you can switch one internal assembly to interchange electric or pneumatic units . . . for use with any existing receiver. The *TransiTWINS* are interchangeable with Mag Na Vue indicators, too, without change of float or float extension, without taking the meter from the line . . . in the biggest step ever taken toward standardized flow instrumentation.

To your technical sense, the high-resolution, transmission accuracy of the *TransiTWINS* will be an eye-opener.

To your practical sense, the maintenance simplicity of this rugged instrument line will be amazing.

If you *can* wait, send for Bulletin 170.

If you *can't*, telephone your nearby Brooks representative.



Send for Bulletin 170.

Brooks, TransiTwins, Mag Nu Matic, Elec Tru Matic and Mag Na Vue are trade names of the Brooks Rotameter Co.

For more information circle **32** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

Harold Hechtman
AIL

John Van Putten
TRIO

Paul Saint-Amour
KEITHLEY

Walter W. Slocum
WESTON

People IN THE NEWS

BRUSH ELECTRONICS CO. announces appointment of *David M. Gaskill* as manager of industrial equipment sales.

ASSEMBLY PRODUCTS, INC. announces that *Robert E. Jones* has been appointed manager of meters and contact meter-relays.

KEITHLEY INSTRUMENTS, INC. announces two new appointments: *Paul Saint-Amour* as sales engineer (with additional activities in sales promotion and representative relations), and *Donald R. Sinclair* as works manager.

WESTON ELECTRICAL INSTRUMENT CORP. has a new executive vice president: *Walter W. Slocum* has been elected to this post.—Simultaneously, appointment of *Russel A. Schlegel* as general sales manager, and *John R. Hemion* as his assistant has been announced.

BAILEY METER'S Metrotype Div. has a new sales manager—*Robert S. Darke.*

SAMUEL MOORE & CO. has appointed *Richard A. Matthews* as project engineer to its staff.

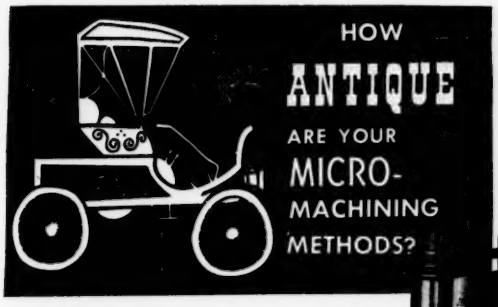
AIRBORNE INSTRUMENTS LABORATORY announces promotion of *Harold Hechtman* to director of public relations.

INTERNATIONAL BUSINESS MACHINES CORP. has appointed *Theodore J. Weppner* as director of advertising and sales promotion for the Data Process Div.

HELIPOT DIV. OF BECKMAN INSTRUMENTS has named *Albert Diamond* chief engineer of the rotating equipment department; *Stanley Schneider* has been designated chief research engineer; *Frederick Marsh* will be the division's new chief customer engineer; and *James F. Gordon,* chief development engineer will assume control of all design work and advanced engineering pilot plant operation.

TRIO LABORATORIES, INC. has added *John Van Putten* to its staff in the capacity of technical promotion manager.

DAYSTROM, INC. announces appointment of *Dr. Charles F. Taylor* as systems engineer in the Systems Div.



SMALL DRILLS MUST BE HELD
IN PRECISION COLLETS TO ASSURE ACCURACY

LEVIN® MICRO-DRILL PRESS

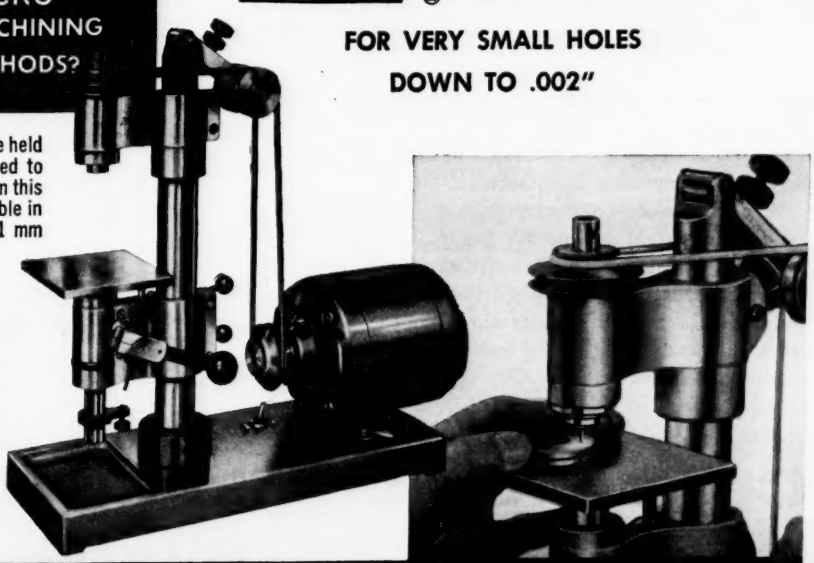
FOR VERY SMALL HOLES
DOWN TO .002"

In the LEVIN micro-drill press drills are held in precision collets. Runout is reduced to practically zero and drill breakage from this cause is eliminated. Collets are available in a complete range of sizes down to .1 mm (.004").

SPECIFICATIONS:

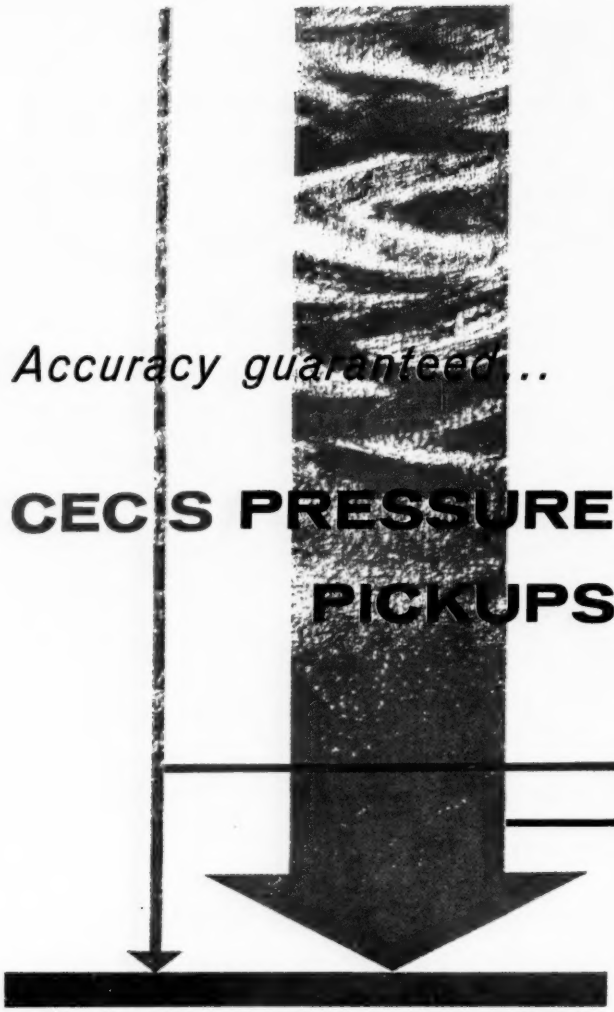
Size of table is 3-3/4" x 4". Maximum table travel is 1-1/2". Greatest distance between table and end of spindle 4". Preloaded ball bearing spindle with four speeds 1725, 2600, 3000, 4700 RPM. Motor 1/2 HP, 110V, 60C. The micro-drill press may also be had with a 3450 RPM motor, doubling the above speeds.

Send for catalog M describing complete line of micro-drilling equipment, collets, instrument lathes and precision tools.



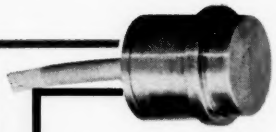
LOUIS LEVIN & SON, INC.—3610 S. BROADWAY—LOS ANGELES 7, CALIFORNIA

For more information circle **33** on inquiry card.

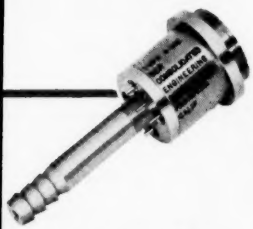


Accuracy guaranteed...

CEC'S PRESSURE PICKUPS



TYPE 4-311
Gage models: 100 to 5000 psi, flush-mounting, weighs 40 grams. Bulletin 1539-X4.

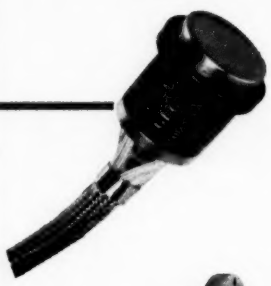


TYPE 4-312
Absolute, differential, or gage models: 15 to 150 psia, ±5 to ±25 psid, 10 to 150 psig, flush-mounting, weighs 12 grams. Bulletin 1540-X4.

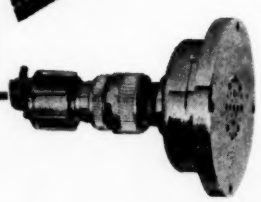
TYPE 4-313
Absolute or gage models: 100 to 5000 psi, flush-mounting, weighs 30 grams. Bulletin 1541-X12.

TYPE 4-314
Absolute or gage models: 1000 to 5000 psi, 3/4-16 AN (male) thread, weighs 55 grams. Bulletin 1553-X12.

TYPE 4-315
Differential and gage models: ±1, ±2, ±3 psid, 5 psig, 1/8-27 NPT (female) connection, weighs 60 grams. Bulletin 1556-X20.



TYPE 4-316
Differential and gage models: ±7.5 to ±25 psid, 15 to 150 psig, operates continuously at 600°F, weighs 15 grams. Bulletin 1568-X23.



TYPE 4-340
Employs electro-kinetic principle. Flat frequency response 3 cps to 25,000 cps. Output 350 mv/psi self-generating, 10^{-4} to 100 psig. Bulletin 1573-X14.

...for every application

Your best assurance of reliable final pressure data is a Consolidated Pressure Pickup, *application-rated for your requirements*. Each pickup is guaranteed and individually calibrated by CEC for accuracy and dependable performance.

Extensive evaluation of customer needs, combined with research and development, brings you this family of pressure pickups especially suited for measurement and control applications involving severe vibration, acceleration, and ambient-temperature variations. Standard types cover the pressure range from 1 to 5000 psi and the temperature range from −65°F to 600°F.

For complete specifications, please write for the specific bulletins indicated, or contact your nearby CEC field office.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

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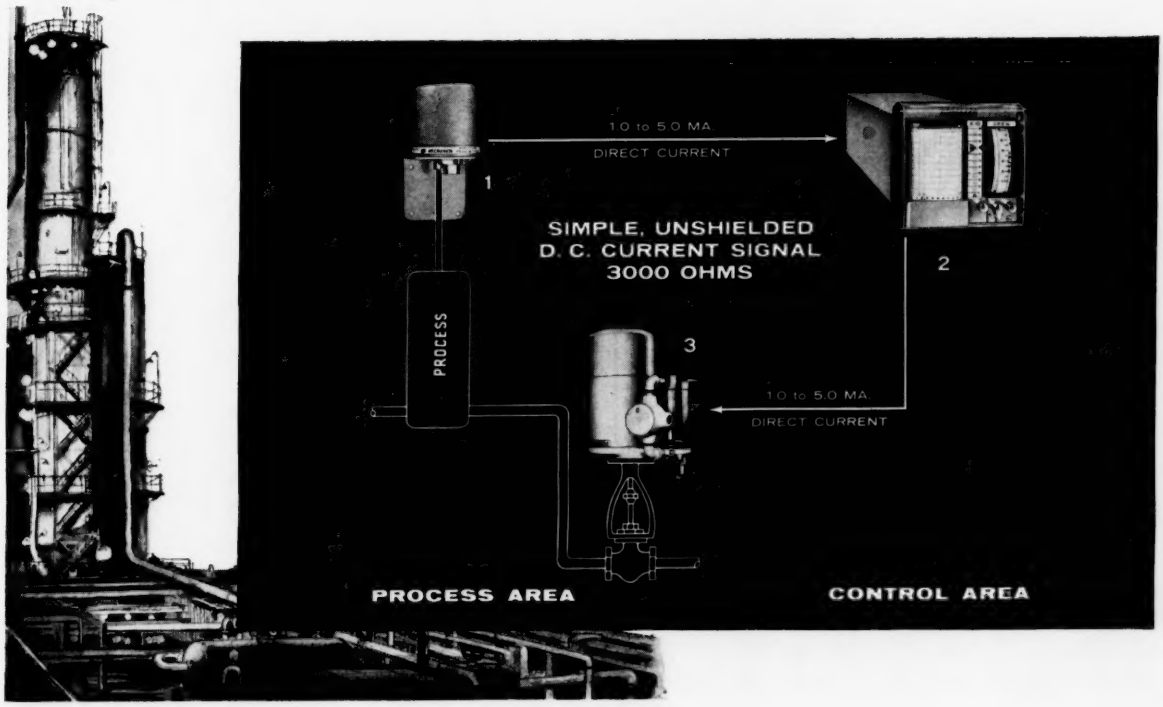


Let's look at a typical control loop of the 'American-Microsen' *ELECTRONIC PROCESS CONTROL SYSTEM*

This all-electronic dc system of miniature-type units assures the instrument engineer of 1) better control; 2) greater flexibility; 3) lower initial costs; 4) lower operating costs. The typical control loop above demonstrates the simplicity and functions of the system.

1. Transmitter. 'American-Microsen' transmitters are used for measuring pressure, temperature, differential pressure, liquid level, flow, and other process variables. The "Microsen" balance creates a stable dc signal for long distance transmission. Transmitters have no bearing pivots or linkages — assuring sensitivity and repeatability of measurement. Small size is made possible by printed circuitry and miniaturized components. The unit can be installed on meter piping, pipe pedestal or vertical surface.

2. Controller. A single unit combines all functions of measuring and recording or indicating the input signal; producing the control signal; and allowing manual-automatic process operation. Separate plug-in chassis provides the following functions: *A.* Records or indicates process variable. Strip or card chart recorder chassis available. *B.* Produces proportional, reset and rate control actions to regulate the variable. All control settings are calibrated. *C.* Permits switching to manual operation during start-up or emergency conditions, with true "bumpless" transfer from manual to automatic control.

Transistorized design increases reliability and service life. Miniaturization and consolidation of control functions reduces panel cost and wiring expense.

3. Electro-Hydraulic Control Valve Operator. A power unit with position feedback that operates slip-stem control valves. No compressed air is needed. Mountable on standard yokes supplied with conventional slip-stem control valves with bodies of single or double-seated construction, with V-port, parabolic, needle and equal percentage plugs, including valves of 4" stroke, and force available up to 3,250 lbs.

Where required, the American-Microsen Electro-Pneumatic Valve Positioner or the Electro-Pneumatic Transducer can be supplied.

In automating your processes for higher product quality and greater operating economy, you want the better control and simplified servicing provided by the American-Microsen Electronic Process Control System. We invite you to meet with one of our sales engineers to determine the best equipment for your service. Write for literature.

MANNING, MAXWELL & MOORE, INC.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

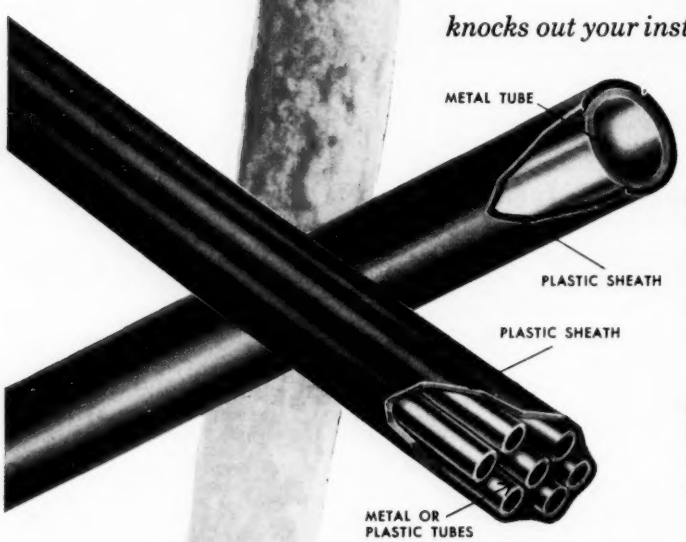
INDUSTRIAL CONTROLS DIVISION • STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

For more information circle **37** on inquiry card.

DEKORON INSTRUMENT TUBING

knocks out your instrument line corrosion problems



DEKORON single-line tubing. Samuel Moore & Co. will coat your copper, aluminum or steel tubing by the Dekoron extrusion process, or will supply coated tubing. Straight lengths to 20 ft., coils to 1000 ft.

DEKORON IMPERVAPAK is a multiple tube harness of plastic or metal tubes encased in tight plastic sheath. Multiple tube construction cuts down installation costs.

Corrosion endangers the life line of your plant—your instrument tubing. That's why you should investigate Dekoron instrument tubing, the tubing that's impervious to moisture, salt air, corrosive atmospheres, and chemicals.

That means Dekoron eliminates replacement costs and maintenance. Other advantages are low initial cost . . . less plant down time . . . easy installation with standard fittings and plastic tape.

In replacement savings alone—not including lower maintenance and installation costs—Dekoron Instrument Tubing pays for itself over and over again.

AA-766

Send for free copy of Bulletin L-6506 "3 Ways to Whip Corrosion and High Tubing Installation Costs in Your Plant."

Dekoron® products

SAMUEL MOORE & COMPANY

For more information circle **36** on inquiry card.

Biographies of significance

SIGNIFICANCE

The biography of Marvin Camras, senior physicist at Armour Research Foundation of Illinois Institute of Technology, is the story of modern magnetic recording. Much of the phenomenal growth in magnetic recording is attributed to his pioneer work, first started while he was a student at Armour Institute of Technology, predecessor of Illinois Tech.

Camras holds more than 85 patents in this country and 100 patents in 21 foreign countries. His pioneer work in magnetic stereophonic sound contributed to the development of sound tracks now used in Cinerama and Cinemascope. His inventions are utilized in nearly all tape and wire recorders, as well as in radio broadcasting, motion pictures, memory units for high-speed electronic computers, instrumentation, guided missiles, and a host of others.

Outgrowths of his inventions in magnetic recording also have influenced the growth and development of instrumentation. Fundamental portions of his research in magnetic recording have been applied for use in memory systems for electronic computers, in seismograms for recording and analysis of earth tremors, oil exploration, structural accelerometers, multiple high-speed temperature recorders, and automatic programming of machinery. Magnetic recording has opened entire new vistas of instrumentation—and we are pleased to acknowledge the tremendous contributions made to this field by Marvin Camras.

MARVIN CAMRAS

Marvin Camras was born in Chicago on January 1, 1916. His interest in science developed early in life. At the age of five, he took apart a flashlight and mounted the parts in a cigar box to make a lantern. A few years later he made a crude telephone, using a pillbox filled with granules of coke as a microphone, and built a wireless receiver and a spark transmitter.

His magnetic recording invention had its inception in experiments he conducted while a 22-year-old student in electrical engineering. Out of a maze of piano wire, coils, and tubes, Camras gave birth to the first practical wire recorder that was later to revolutionize the whole technique of sound transcription and to play a vital military role in World War II.

A graduate of Crane Technical high school, he received his B.S. degree in 1940 from Armour Institute and M.S. in 1942 from Illinois Tech.

Camras joined the staff of Armour Research Foundation in 1940 to perfect the recorder and perform research in remote control, high-speed photography, magnetostriction oscillators, and static electricity. As a result of his investigations, the Foundation owns or controls more than 250 registered patents in many countries.

In 1954, Camras received the John Scott award for scientific achievement—the same honor bestowed on such notables as Thomas Edison, Orville Wright, and Madame Curie. The 138-year-old award, consisting of $1,000 in cash, a copper medal, and a scroll, was presented to Camras for his discoveries and subsequent improvements in magnetic recording that helped skyrocket this field into an $80 million annual industry.

He received the Illinois Tech alumni distinguished service award in 1948 and the U.S. Camera award for contributions to motion picture photography in 1949.

A fellow in the Institute of Radio Engineers and the Acoustical Society of America, he is a member of the Chicago Physics Club, Chicago Acoustics and Audio group, Radio Engineers Club of Chicago, American Association for the Advancement of Science, Institute of Electrical Engineers, Society of Motion Picture and Television Engineers, Eta Kappa Nu, Tau Beta Pi, and Sigma Xi.

Camras resides with his wife, two sons and daughter at Glencoe, Ill.

Career News for Engineers!

Flight Tests are under way on one of America's most important defense projects:

The Navaho Strategic Missile

Artwork based on Official U.S. Navy Photograph

The results are secret—but this much can be told. A test vehicle designated the X-10 has gathered new aerodynamic and electronic information which will help to speed progress on the SM-64 Intercontinental Strategic Guided Missile.

The opportunity—and the privilege—to implement this revolutionary data is yours.

Twenty-eight-year-old Army vet **WILLIAM T. SCHLEICH** was graduated from Georgia Tech in 1952 with a BSAE. He joined North American as a junior engineer the same year. Seven months later Bill was promoted to aerodynamics engineer for the Navaho missile program. He was appointed Supervisor, Stability and Control Unit in October of last year. With the help of North American's Educational Refund Plan, he received his MSAE from USC. Bill and his wife are hi-fi enthusiasts and have a sound system built into their Whittier, California home.

If you accept this challenge you'll be solving tomorrow's problems—today. Here facts are collected fresh daily. If yesterday's yield proves inconclusive you'll approach the problem from a new direction. You'll travel new paths and develop new inventiveness. And you'll be guided to each breakthrough by the world's best-informed missile authorities—your own associates.

One example of the new hardware evolving from this creative engineering effort is a fully transistorized electronic commutator. This instrument increases the information-relaying capabilities of the missile's telemetering system by commutating 27 outputs at speeds of approximately 100 cycles per second. It was developed by the Flight Test Instrumentation Group.

North American's Missile Development Division is a major center of missile activity—and a pioneer in the field. As far back as 1948 its first test instrument vehicle was fired from a launching platform. Today North American has complete weapons system responsibility for the Navaho—and its test program is being conducted at the Air Force's long-range missile proving ground which stretches more than 5000 miles across the Caribbean and far into the South Atlantic.

LYLE C. BJORN has lived aviation all of his life. As a high school boy he built a glider modeled after the Wright Bros.' first flying machine—flew it from ski jumps near his Utah home. He studied engineering at Utah State and earned his BSME degree from the U of Wyoming. Lyle joined North American in 1951 and is now Group Leader, Field Test Operations at the Missile Test Facility, Patrick Air Force Base, Florida. He lives with his wife and three children near Cape Canaveral where he is an active leader in Cub Scouts.

If this sounds like the kind of career-opportunity you've been looking for—write us today. We promise you a working climate that stimulates personal growth and rewards it with responsibility, professional recognition and material benefits limited only by your own ability. Further, you can continue to grow academically with the aid of our Educational Refund Plan—and some of the nation's finest universities are nearby.

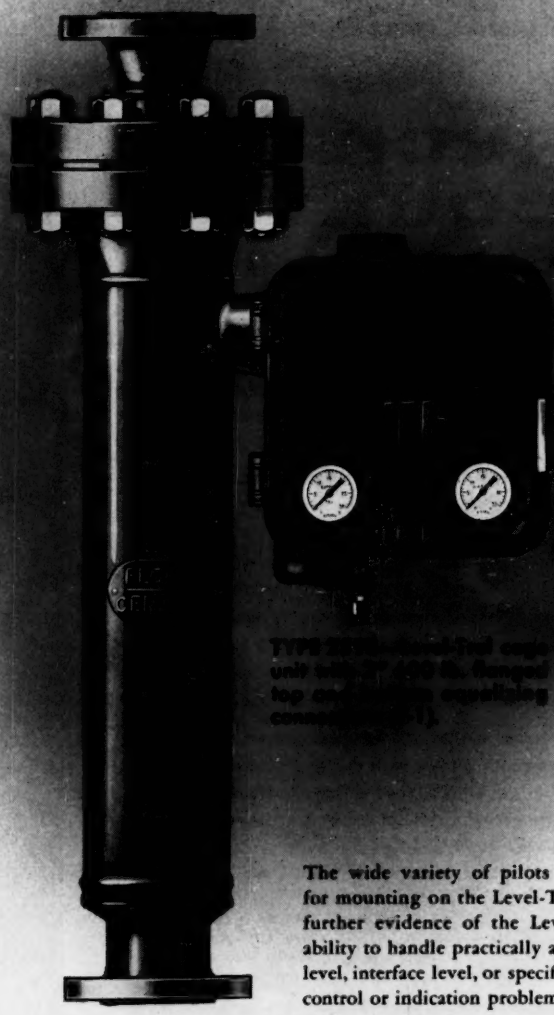
Let us know what kind of creative engineering interests you. (Please include highlights of your education and experience).

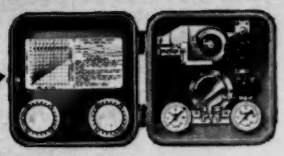
CONTACT: Mr. R. L. Cunningham, Engineering Personnel Manager, Dept. 495-IA-4
Missile Development Division, 12214 Lakewood Blvd., Downey, California.

NORTH AMERICAN AVIATION, INC.

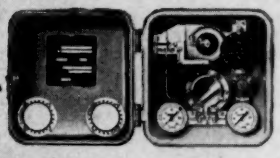
FISHER®
LEVEL-TROL

The Answer to Your Liquid Level Needs

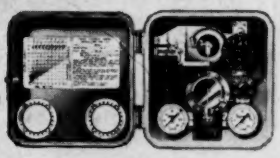




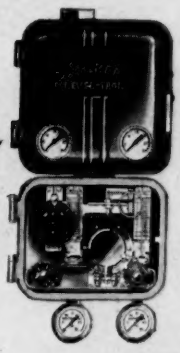
TYPE 2500—proportional pilot for general liquid level control applications.



TYPE 2500T — Level-Trol pilot used as pneumatic level transmitter.



TYPE 2500C—pilot with level indicator. Indicator available on all style Level-Trol pilots.



TYPE 2500 — 2516 dual Level-Trol pilot consisting of Type 2500 for remote level-indication or recording and Type 2516 controller with proportional and reset response.

The wide variety of pilots available for mounting on the Level-Trol gives further evidence of the Level-Trol's ability to handle practically any liquid level, interface level, or specific gravity control or indication problem.

FISHER GOVERNOR COMPANY

MARSHALLTOWN, IOWA • WOODSTOCK, ONTARIO

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER *Since 1880*

For more information circle **38** on inquiry card.

PRECISION COUNTS

IN CAPILLARY TUBE

Capillary tube has to be dead accurate if it is to meet the specifications demanded by manufacturers of thermostats, pressure gauges or other instruments.

That's why Wolverine Tube is proud to offer Wolverine Capilator®—the tiny, capillary tube that does such a big job in the precision metering of liquids, gases and air. Because it is plug drawn, Capilator's inside surface is mirror-smooth for unimpeded flow. Capilator is held to such close tolerances that it can be produced to the flow specifications asked for by the customer. Before shipment each length of Capilator has its ends chamfered, is washed and individually flow tested. Ends are paper wrapped for absolute cleanliness.

Wolverine also manufactures small diameter tubing in a wide range of alloys, wall thicknesses and sizes. To be sure of precision control always insist on Wolverine Capilator and capillary tube. For complete information write for Wolverine's Capilator Catalog.

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CALUMET DIVISION
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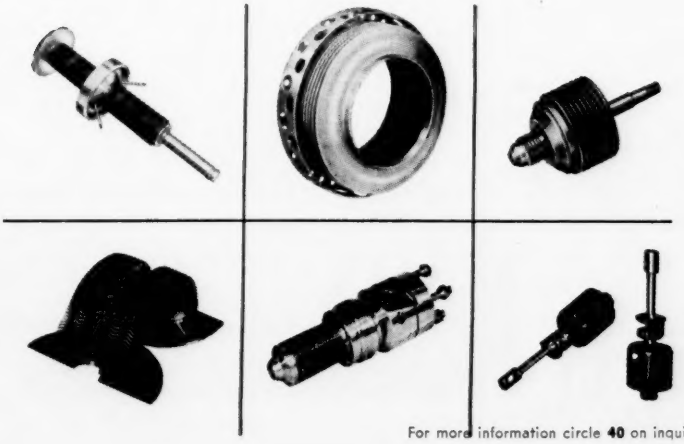
the tough game of high performance

Breeze bellows engineers work in that challenging area where ready-made designs won't do the job. Every project is a custom project, engineered specifically for each problem application.

We have a wealth of experience with all weldable alloys such as Inconel X, titanium, Ni-Span, Hastelloys, Stainless 300 and 400 steels.

We are solving critical problems in instrumentation, fuel regulation, pressure switches and expansion joints, hot air ducting, pressure surge tanks, packless valves, expansion and vibration joints, oscillating and rotating shaft seals, atomic and nuclear reactors.

Breeze invites your inquiries on bellows jobs *beyond the routine* . . . for the most exacting requirements.



BREEZE

CORPORATIONS, INC.

700 Liberty Avenue, Union, N. J.

BREEZE MARK

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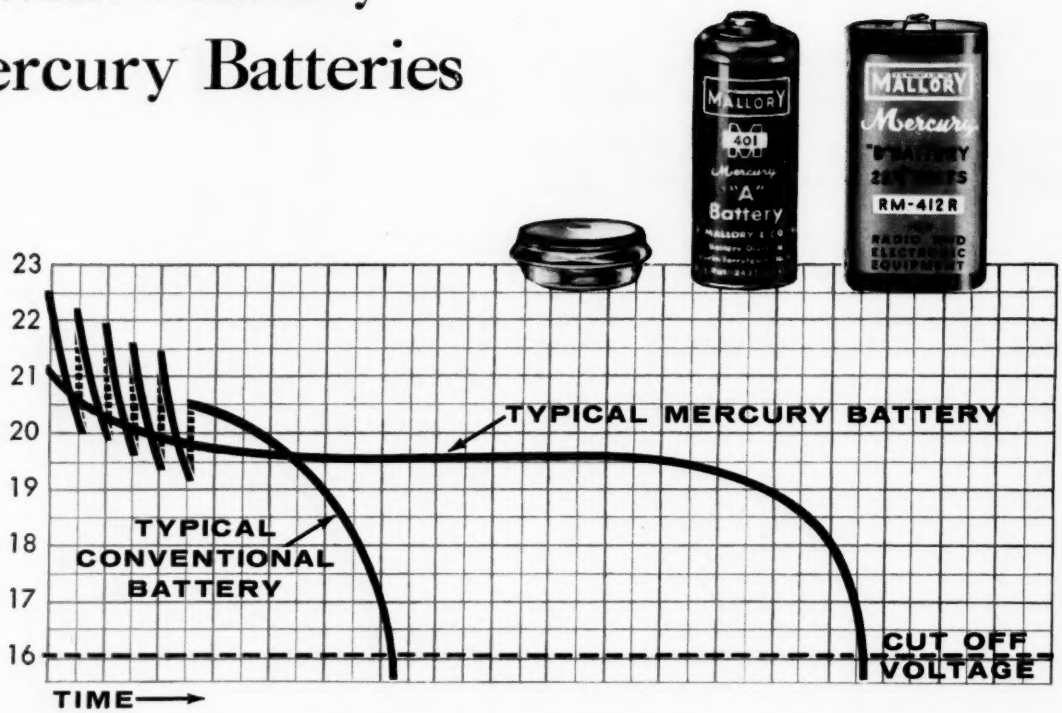
← Circle **39** on inquiry card.

Design for fade-free service with Mallory Mercury Batteries



One of the most unusual characteristics of unique Mallory Mercury Batteries is that they stay at constant output throughout their long life . . . instead of gradually losing power like conventional batteries.

This characteristic is especially important in transistor circuits, which require a constant energy source. In instrument circuits and bias cell applications, the constant voltage output of Mallory Mercury Batteries protects accuracy and serves as a reliable secondary voltage standard.

Pioneered and refined by Mallory during many years of leadership in battery progress, the mercury battery has made available to designers a portable energy source with qualities never before approached. Its high energy in small volume permits miniaturizing equipment to new standards of compact size . . . for portable radios, portable instruments, military electronic equipment. Its extremely long life . . . several times that of conventional batteries . . . multiplies reliability of equipment, reduces frequency of battery changes, increases consumer acceptance. Its ability to withstand high temperature and humidity extends the field of application of self-powered equipment. And its low cost per hour of service makes new battery-operated products economically attractive.

Write to Mallory today for technical data on the complete line of voltage and milliampere-hour ratings available, and for a consultation with a Mallory battery specialist.

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical — Resistors • Switches • Tuning Devices • Vibrators
Electrochemical — Capacitors • Mercury and Zinc-Carbon Batteries
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Expect more . . . get more from

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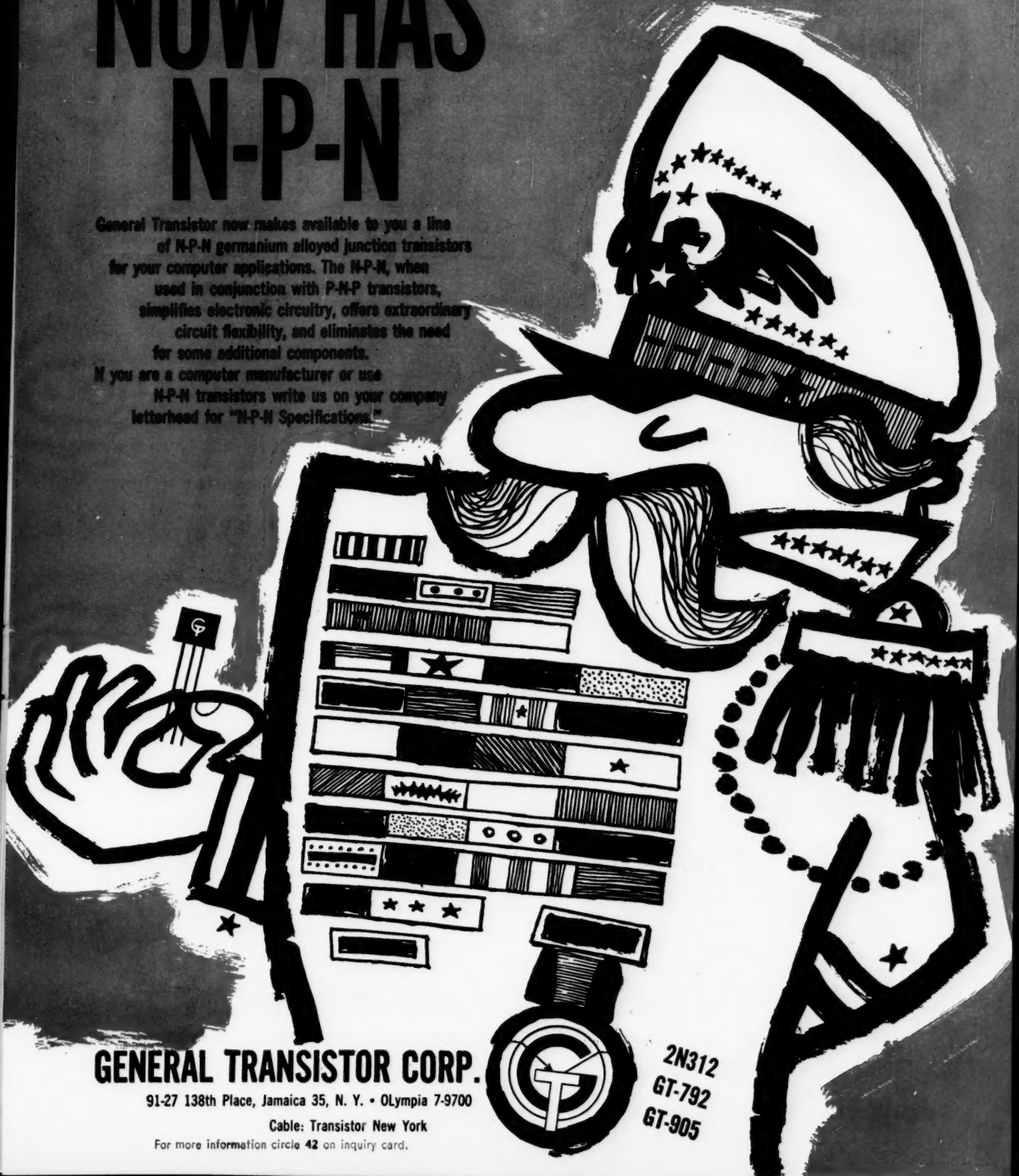
MALLORY
P. R. MALLORY & CO. Inc., INDIANAPOLIS 6 INDIANA

For more information circle **41** on inquiry card.

GENERAL NOW HAS N-P-N

General Transistor now makes available to you a line of N-P-N germanium alloyed junction transistors for your computer applications. The N-P-N, when used in conjunction with P-N-P transistors, simplifies electronic circuitry, offers extraordinary circuit flexibility, and eliminates the need for some additional components.

If you are a computer manufacturer or use N-P-N transistors write us on your company letterhead for "N-P-N Specifications."



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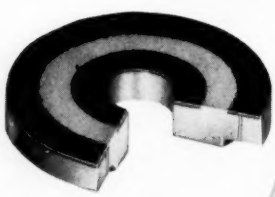
FOR INDUSTRIAL ELECTRONIC APPLICATIONS

NEW TYPE H 5-WATT molded composition VARIABLE RESISTOR

With this new development, you get all the advantages of the well-known Allen-Bradley Type J unit, but in a 5-watt rating. The Type H variable solid molded composition resistor is ideal for laboratory or industrial applications where reliability, velvet smooth control, and long life without resistance change are important. The dual track in the Type H control eliminates all moving metal-to-metal electrical contacts, making it outstanding for its low "noise" characteristics, both initially and after long use. The Type H control varies only insignificantly under changing temperature and humidity conditions. Its operating life is far in excess of 100,000 cycles, with no appreciable change in resistance.

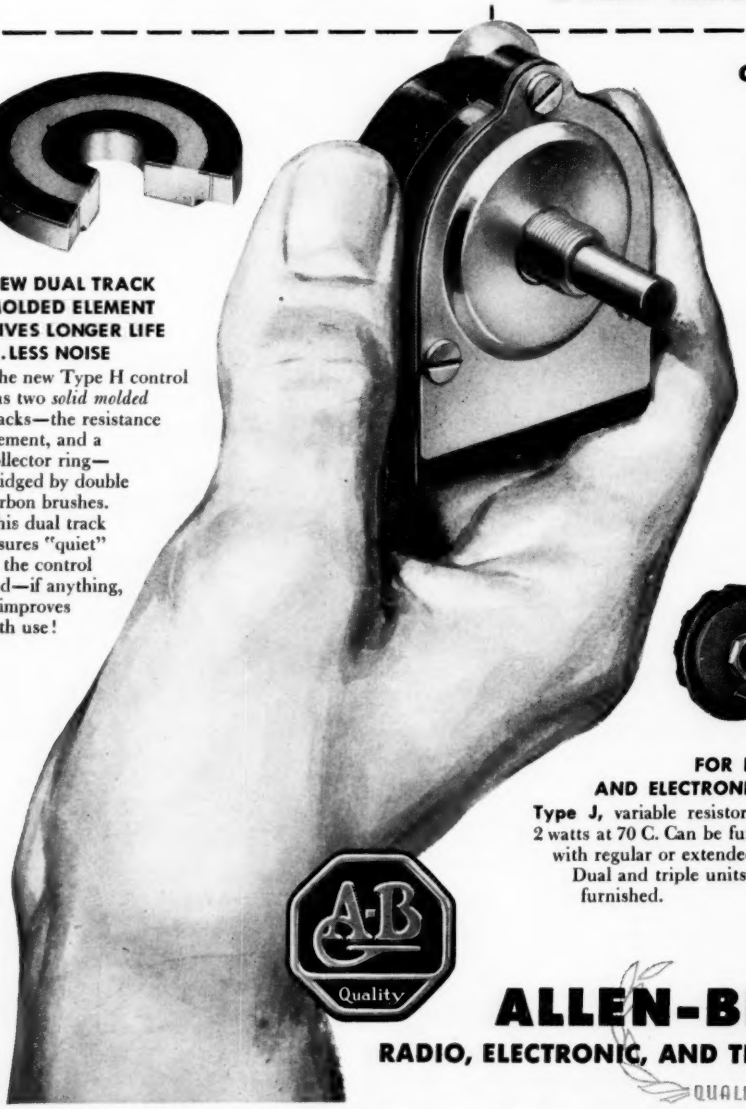
You'll have many applications for this new Allen-Bradley *quality* control. Try it!

Allen-Bradley Co.
140 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.



NEW DUAL TRACK MOLDED ELEMENT GIVES LONGER LIFE ...LESS NOISE

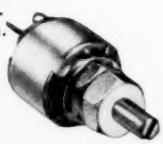
The new Type H control has two *solid molded* tracks—the resistance element, and a collector ring—bridged by double carbon brushes. This dual track assures "quiet" in the control and—if anything, it improves with use!



OTHER ALLEN-BRADLEY VARIABLE RESISTORS

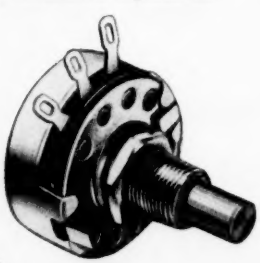
FOR PRINTED CIRCUITS
Type F, ¼-watt variable resistor (½-inch diam). Similar to Type G, below. Slotted screwdriver shaft.

FOR SUBMINIATURE ASSEMBLIES
Type G, ½-watt variable resistor (½-inch diam). Plain or lock-type bushing; plain or slotted shaft. Available with switch.



FLAT, COMPACT DESIGN
Type T, ½-watt variable resistor (1-inch diam). Supplied for hand or screwdriver adjustment.

FOR RADIO AND ELECTRONIC USE
Type J, variable resistor, rated 2 watts at 70 C. Can be furnished with regular or extended shaft. Dual and triple units can be furnished.



ALLEN-BRADLEY
RADIO, ELECTRONIC, AND TELEVISION COMPONENTS
QUALITY

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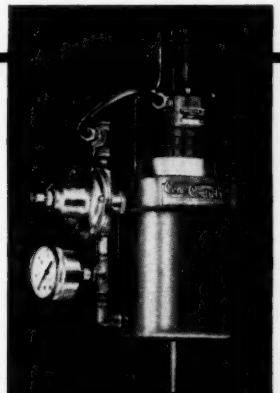
CONOFLOW *Shows You the Way to* AUTOMATION

HERE'S HOW

YOUR PROCESSING EQUIPMENT + INSTRUMENT +

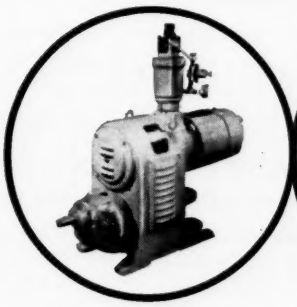


= COST-CUTTING AUTOMATION

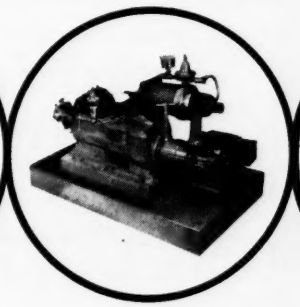
The Conoflow Cylinder Conomotor—a powerful pneumatic actuator—has accelerated industry's approach to the automatic factory and the continuous process plant. A wide range of final control elements, never before available, has been created by the Cylinder Conomotor, a servo capable of following the exact signal outputs of modern electronic and pneumatic instruments.

Cylinder Conomoters, acclaimed by industry as the ultimate in control valve actuators, are fast becoming the standard for automatic control of other process regulating equipment. A few of these are: motor driven speed changers, proportioning pumps, flow regulators, electric timing devices, and numerous electrical systems components such as rheostats, autotransformers and potentiometers.

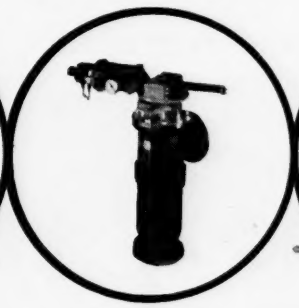
A FEW EXAMPLES OF CONOFLOW AUTOMATION . . .



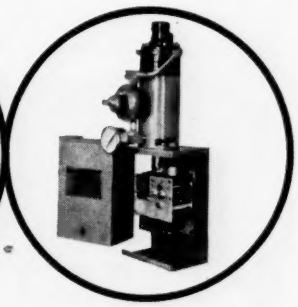
U.S. Electrical Motors
Variable Speed Drive



Proportioneers
Proportioning Pump



Kates
Flow Regulator



Dorr-Oliver
Electric Timer

Conoflow application engineers, well versed in systems engineering methods, will gladly help you evaluate the use of the Cylinder Conomotor on your equipment. Avail yourself of the tremendous advantages offered by this concept of automation, including increased productivity . . . savings in man power . . . improved quality control . . . and many other benefits. Call or write today for "personalized" service. Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa. Representatives in principal cities.

WRITE FOR BULLETINS B-50-2-A AND EB-2-A

CC-700

Cono-Controls®

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

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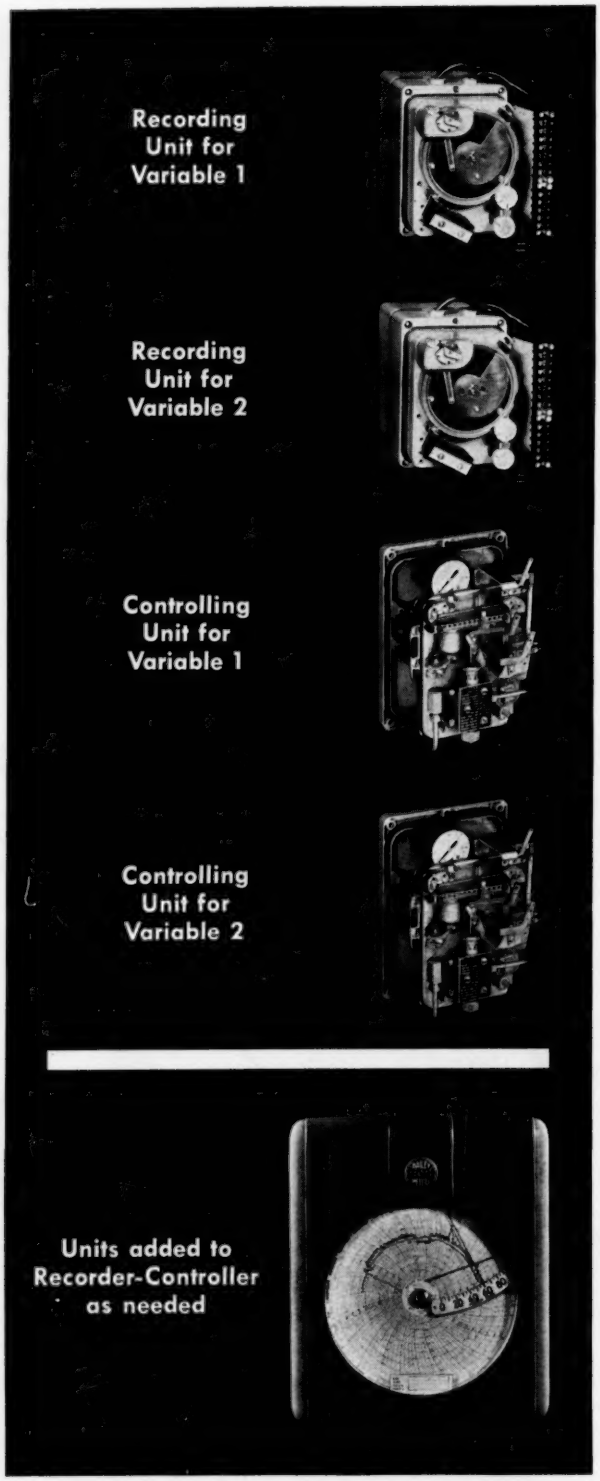
Recording Unit for Variable 1
Recording Unit for Variable 2
Controlling Unit for Variable 1
Controlling Unit for Variable 2
Units added to Recorder-Controller as needed

Bailey Recorder is key to "step-by-step" automation

When you are pioneering a new process and don't know all the answers, complete automation is seldom practical. The first step is to identify your variables and measure them. Nothing does this job better than a Bailey Recorder. One instrument can record any four variables that can be converted to electric *or* pneumatic signals.

Once you get a better understanding of the variables in your process, you will want to add controls and feed back your measurements. Here's where the versatility of the Bailey Recorder comes into play. For the same Bailey instrument you use to record variables is designed to accommodate plug-in control units.

When you use a Bailey Recorder, you can build your instrumentation along with your process. At the start, you use only the plug-in units for recording. Then you add plug-in controls as you see the need for them.

For the complete story of how you can use a Bailey Recorder for step-by-step automation, see your Bailey Engineer. G-42-1

Instruments and controls for power and process

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BAILEY METERS

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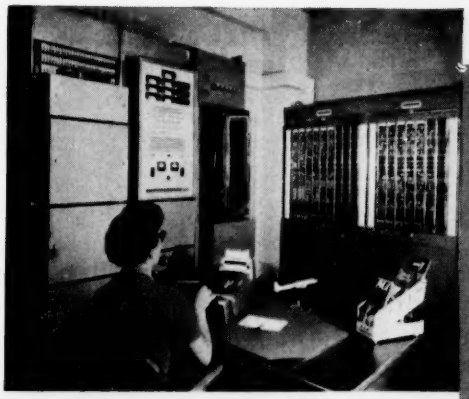

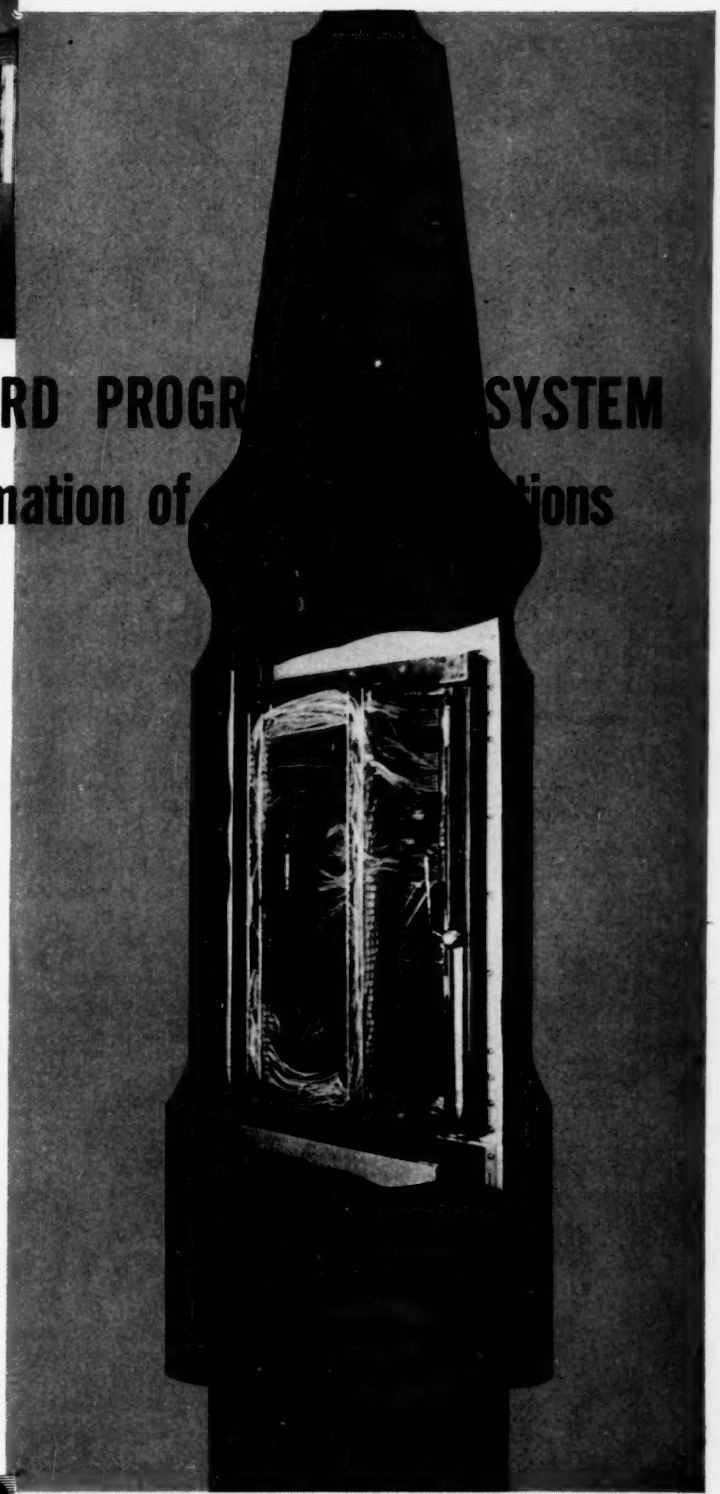

AMP'S PATCHCORD PROGR SYSTEM

Speeds confirmation of tions

A wide variety of AMP Taper Technique product provides long-life assurance of perfect electrical terminations and is a contributing factor in keeping electronic equipment compact. The AMP Patchcord Programming System offers a multiformity of internal wiring arrangements and connections and permits circuit versatility by use of prepatched, removable front boards.

A number of major airlines, including the Long Island City facilities of Pan American Airlines (shown above), have installed electronic equipment manufactured by Teleregister Corporation, Stamford, Connecticut to eliminate delay and uncertainty in air travel reservations procedure. AMP Taper Technique and AMP Patchcord Programming Systems are prominent in the design of this equipment.

AMP Taper Technique and AMP Patchcord Programming Systems have been utilized for years to solve problems inherent in the design of computers, business machines, and automatic control equipment.

Complete information is available on request.

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Japanese Distributors: Oriental Terminal Products Co., Ltd., Tokyo, Japan

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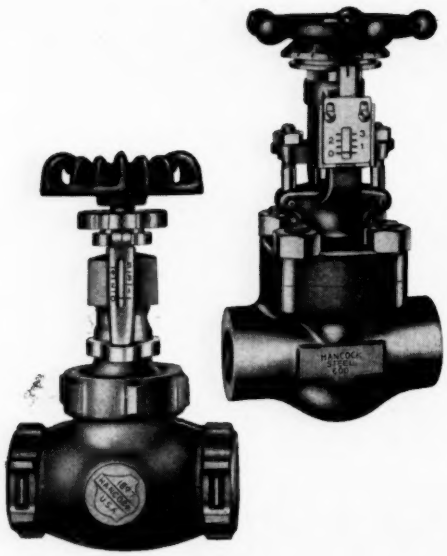
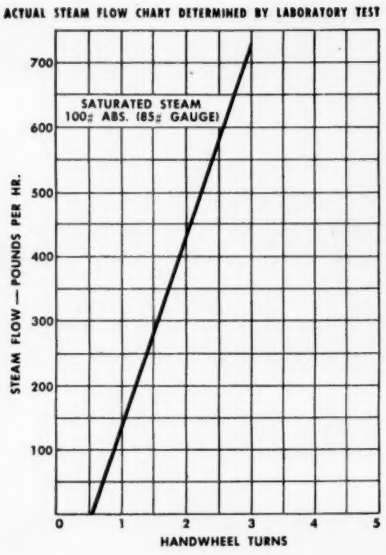




HANCOCK "Flocontrol®" VALVES

- ✓ **Insure Uniform Quality Through Closer Control**
- ✓ **Save Steam and Fuel on Process Work**
- ✓ **Save Money by Cutting Maintenance**

Hancock "Flocontrol" Valves provide a 3-in-1 design that combines variable orifice, shut-off and index. The valve opening can be set to within one-tenth of a turn of the handwheel. The micrometer dial and pointer make it easy to duplicate any desired setting instantly.

Each valve has a scientifically designed V-port valve disc that insures proportional flow throughout the entire lift of the stem. Straight line flow with separate shut-off seating surface removed from the controlling V-ports eliminates the need for a separate shut-off valve.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet specific requirements. All are rugged valves, designed and constructed to provide the *economy of quality* so essential to assure top performance in the most demanding services.

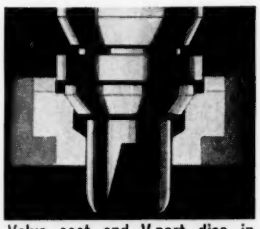
Hancock Bronze "Flocontrol" Valves. *Types:* Globe and Angle. *Sizes:* ¼" through 2". *Connections:* Screwed Ends. "500 Brinell" Stainless Steel Seats and Discs. 150# Series for all pressures up to 150 psi at 358° F. 300# Series for all pressures up to 300 psi at 550° F.

Hancock Forged Steel "Flocontrol" Valves. *Types:* Globe and Angle. Renewable Hard-Faced Stainless Steel Seats. "500 Brinell" Stainless Steel Discs. *Connections:* Screwed, Socket Weld and Flanged Ends. *Sizes:* Screwed and Socket Weld Valves—¼" through 2". Flanged Valves—½" through 2". *Screwed and Socket Weld Valves:* For all pressures up to 600 psi at 910° F. O.W.G.—2000 psi at 100° F. *Flanged Valves:* For all pressures up to 600 psi at 850° F. O.W.G.—1440 psi at 100° F.

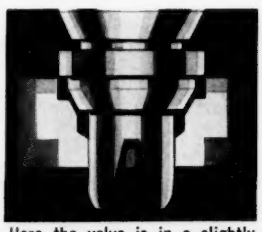
Hancock Cast Steel "Flocontrol" Valves. Globe Type with Screwed Bonnet. Renewable Stainless Steel Plug Seats and Discs. *Sizes:* 2½" and 3". *Connections:* Screwed and Flanged Ends. For all pressures up to 395 psi at 775° F. O.W.G. —720 psi at 100° F.

Hancock Cast Steel "Flocontrol" Valves. Globe type with Bolted Bonnet. Renewable Stainless Steel Plug Seats and Discs. *Sizes:* 2½", 3" and 4". *Connections:* Flanged Ends. 300# Series for all pressures up to 395 psi at 775° F. O.W.G.—720 psi at 100° F. 600# Series for all pressures up to 800 psi at 775° F. O.W.G.—1440 psi at 100° F.

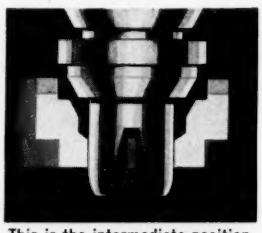
HANCOCK "FLOCONTROL" VALVES OPERATE LIKE THIS . . .



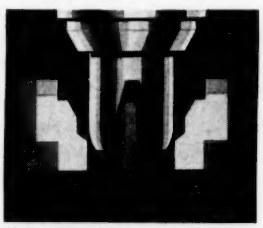
Valve seat and V-port disc in fully closed position. Pressure pushes upward under the disc. Note that the shut-off seating surface is completely removed and separate from the flow-controlling V-ports.



Here the valve is in a slightly opened position. The V-port disc is permitting a measured flow of the media.



This is the intermediate position. Note that the V-port disc now permits a proportionally greater flow of the media.



Fully opened valve provides maximum flow. The special micrometer dial and pointer permit any open position to be duplicated accurately.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your telephone. Let him help you select the right Hancock "Flocontrol" Valves for your needs. You can depend on him for fast delivery from local stocks.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

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Inquiries

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Electrocardiograph

Manufacturer of carrying cases is interested in obtaining information for the design and operation of electrocardiographs. A-208

Digital Readout Tubes

British manufacturer of electric controls seeks information on digital indicator tubes to be used for digital display in a system to control a complex chemical process from punched tape. A-209

Knurled Knobs

Importer of watchmakers' and jewelers' tools seeks sources of supply of small knobs with straight, slanting, and diamond knurl ($\frac{5}{16}$" to $\frac{25}{32}$" approx. dia) for an overseas manufacturer. A-210

Paper Tension

Reader seeks recording instrument to measure tension in paper. A-211

Encephalograph

Reader in Sweden is interested in obtaining names and addresses of manufacturers of encephalographs. A-212

Optical Cements

Optical company seeks optical cements (particularly of the solid type, such as epoxy resins) which cure at or near room temperature in a short time. Storage with moderate to long shelf life at room temperature is preferred. A-213

Automatic Inspection

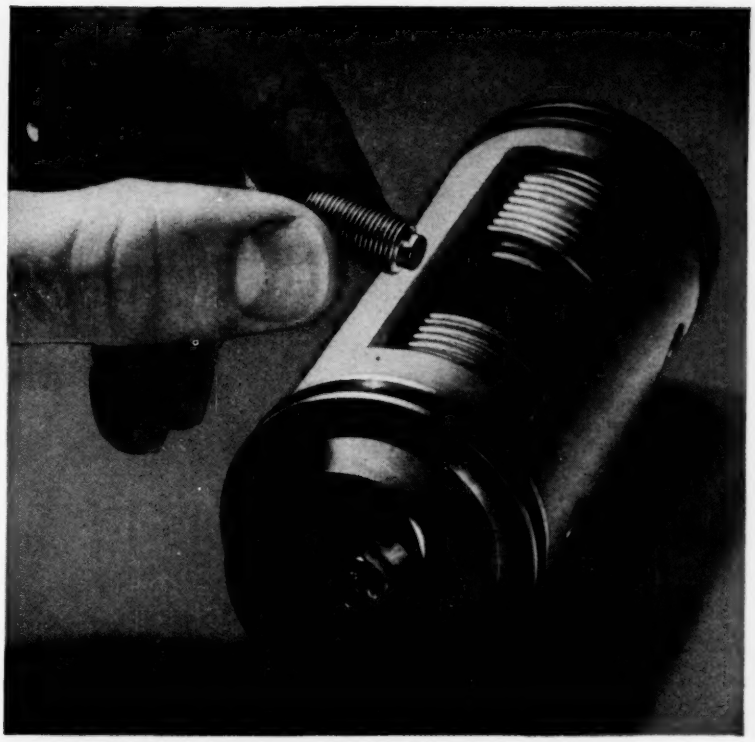
Chief inspector of computer manufacturer seeks literature on equipment for automation of electronic parts inspection. A-214

Odor Testing Instrument

Plastics Division of manufacturing concern seeks odor testing equipment. A-215

Prospecting Equipment

Party interested in building own prospecting equipment seeks contact with manufacturers of oscillator-type mineral detectors, high-frequency magnetic separators, spectroscopes, and mineral locators registering positive peak over ferrous ores, and negative over non-ferrous ores (working on ground currents). Mineral detector and mineral locator should be portable. A-216



Bridgeport BELLOWS AND ASSEMBLIES PERMIT GREATER DESIGN FREEDOM

Bridgeport bellows bring an extra measure of strength, safety and stability to any bellows application. And to help you realize these advantages to the fullest, Bridgeport can supply bellows in the best form for your requirements. There's a choice of single or multiple-ply construction, many different heads and ends, sizes from ¼" to 5⅞" O.D., and a wide variety of metals—brass, phosphor bronze, beryllium copper, stainless steel, monel.

With its specialized engineering staff and all-new plant, Bridgeport is also better able to integrate the engineering and production of complete bellows assemblies. The latest high-speed, precision equipment and quality control facilities enable Bridgeport to supply any assembly at lowest cost . . . with uniformly high quality.

SEND FOR BELLOWS ENGINEERING BULLETIN GL

Mr. Control

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BRIDGEPORT THERMOSTAT DIVISION • MILFORD, CONN.

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Typical Bishop Thin Wall Tubing

Whether it be for an hydraulic line in a jet engine . . . a precision part for a scientific instrument . . . wherever there is a need for corrosion or abrasive resistance, or where workability or stress are involved, you can *depend* on BISHOP stainless steel tubing.

Where close tolerances, accurate specifications are to be followed . . . when clean I.D. and O.D. are important factors, look no further for quality, specify BISHOP stainless steel tubing—at comparable prices.

Platinum and Platinum Group Metals
Stainless Steel Tubing
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CAPILLARY, MECHANICAL, HYPODERMIC and AIRCRAFT
Stainless Steel Tubing—seamless and welded and drawn
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(.003" to .083" Wall)

NICKEL AND NICKEL ALLOY TUBING
(up to .625" O.D.)
Flanged, Flared, Milled, Slotted, Swaged, Threaded.

Catalog and Prompt Quotations on request.

STAINLESS STEEL PRODUCTS DIVISION

J. BISHOP & CO. Platinum Works

Malvern, Pennsylvania

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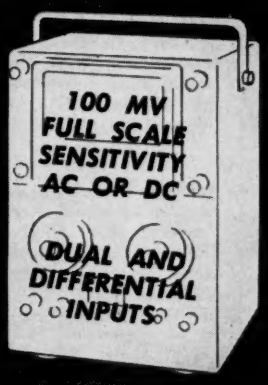
New Du MONT TYPE 405 VTVM



Now there's no need to weigh feature against feature when it comes to vacuum tube voltmeters — the new Du Mont 405 has everything!

The 405 is the first VTVM to combine **100 millivolt** full scale sensitivity, either **AC or DC,** with **dual and differential inputs.** Besides, it features DC performance from **2 millivolts to 1000 volts** with **120 megohm input.** It doesn't stop there, for it also offers highly accurate AC performance from **below 50 cps** up into the **UHF range.** As an **ohmmeter,** the Type 405 is calibrated from **0 to 500 megohms,** in eight ranges.

Another in the outstanding Du Mont 400 Series, the 405 is "human engineered" for ease and convenience of operation, reliability, and precision. Its rugged construction is backed by the exclusive Du Mont 5-year guarantee offered with all instruments of the 400 Series.

Price **$265.00**

Slightly higher in 50-cycle areas.

Write for complete details

FEATURING

- **ACCURACY:** 2%.
- **SCALE:** Illuminated 4" mirror-backed scale for accurate readings.
- **STABILITY:** Very low drift. Less than ± 3 millivolts on any range.
- **VERSATILITY:** Designed for safe off-ground operation up to 1000 volts DC.
- **REGULATED:** Regulated DC and filament supply.
- **AMPLIFIER OUTPUT:** Amplifier output available with power gain over 60 db.
- **SIZE:** Compact, weighs only 12 pounds.
- **PROBE STORAGE:** Built-in probe storage compartment.

DU MONT®

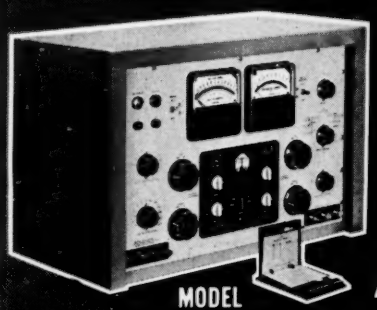
One of the 400 Series

Technical Sales Department, ALLEN B. DU MONT LABORATORIES, INC., Clifton, N. J.

For more information circle **49** on inquiry card.

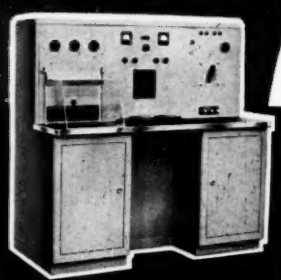
Instrument Calibration

a modern method of maintaining ACCURACY



MODEL 829

Superior and sustained quality control, through frequent calibration of test instruments, can be achieved by semi-skilled personnel using these self-contained standards.



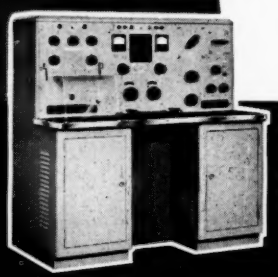
MODEL 261B

Portable Model 829 calibrates both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. Direct reading accuracy of 1% (0.5% using charts supplied). Output frequency from 50 to 400 cps depending on line frequency used.

Net price $2,650.

Console Model 261B calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.

Net price $9,250.



MODEL 262B

Model 262B Dual Potentiometer Standard calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes. Employs Weston instruments and standard cells.

Net price $15,600.

Prices are f.o.b. Boonton, N.J. & subject to change without notice.

WE CAN HELP YOU

Technical and application data for our six basic models are fully described in a new 24-page catalog. Send for it today.

RFL *Radio Frequency* LABORATORIES, INC. Boonton, New Jersey, U.S.A.

For more information circle **50** on inquiry card.

Events

April 22-24

IRD's 3rd Annual Conference on Control System Applications, Northwestern Univ., Evanston, Ill.

April 24-26

Southern California Electronic Conference and Show, Balboa Park, San Diego, Calif. For information write 7th Region IRE Conference, U. S. Grant Hotel, San Diego, Calif.

April 25-26

Annual Technical Meeting of Inst. of Environmental Engineers, La Salle Hotel, Chicago, Ill. For information write Henry F. Sander, Pres. IEE, Vapor Heating Corp., 6420 W. Howard St., Chicago, Ill.

April 27-May 2

39th Annual Meeting of the Scientific Apparatus Makers Association, Greenbrier, White Sulphur Springs, W. Va.

April 29-May 2

Third Flight Test Instrumentation Symposium, Statler Hotel, Los Angeles, Calif. For information write Eugene Spencer, Los Angeles Section, Instrument Society of America, 5225 Wilshire Blvd., Los Angeles 36, Calif.

May 1-3

Electronic Components Symposium, Morrison Hotel, Chicago, Ill. For information write J. S. Powers, Electronic Components Symposium, 84 E. Randolph St., Chicago 1, Ill.

May 2

Committee C-20 on Acoustical Materials, American Society for Testing Materials, ASA Headquarters, New York, N. Y. For information write Fred F. Van Atta, Asst. Sec., A.S.T.M., 1916 Race St., Phila. 3, Pa.

May 7-17

Instruments, Electronics and Automation Exhibit, London, England. For information write British Information Services, 45 Rockefeller Plaza, New York 20, N. Y.

May 9-10

1957 Annual Meeting of the Professional Group on Microwave Theory and Technique, Western Union Auditorium, New York, N. Y.

May 13-16

Seventh Annual Research Equipment Exhibit and Instrument Symposium, National Institute of Health, Bethesda, Md.

May 14-16

Second Annual Industrial Nuclear Technology Conference, Museum of Science and Industry, Chicago 16, Ill. For information write Dr. Leonard Reiffel, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

May 20-22

Convention and Exposition, Armed Forces Communication & Electronics Association. Sheraton-Park Hotel, Washington, D. C. For information write William C. Copp & Associates, 1475 Broadway, New York 36, N. Y.

May 27-29

Third National Telemetering Conference, Hotel Cortez, El Paso, Texas. For information write J. M. Sherman, Exhibits Committee chairman, Electro-Mechanical Resistors, 4933 Mesa Road, El Paso, Texas.

June 10-11

Second RETMA Symposium on Applied Reliability, Hotel Syracuse, Syracuse, N. Y. For information write J. A. Caffiaux, RETMA Engineering office, room 650, 11 W. 42 St., New York 36, N. Y.

June 10-14

Symposium on Molecular Structure and Spectroscopy, Department of Physics and Astronomy, The Ohio State University. For information write H. H. Nielsen, Chairman, The Ohio State University, Columbus 10, Ohio.

June 13-15

Third National Symposium on Instrumental Methods of Analysis, University of Chicago, Chicago, Illinois. For information write M. D. Weiss, Program Chairman, Fischer & Porter Co., Hatboro, Pa.

June 19-21

Twelfth Annual Meeting of the Association for Computing Machinery, University of Houston, Houston, Texas. For information write J. F. Summers, The Texas Co., P. O. Box 2332, Houston 1, Texas.

September 9-13

12th Annual ISA Conference & Exhibit, Auditorium, Cleveland, Ohio. For information write William Kushnick, 313 Sixth Ave., Pittsburgh 22, Pa.

Circle **51** on inquiry card. →

NEW TEFLON

SUBMinax®

COAXIAL CABLES

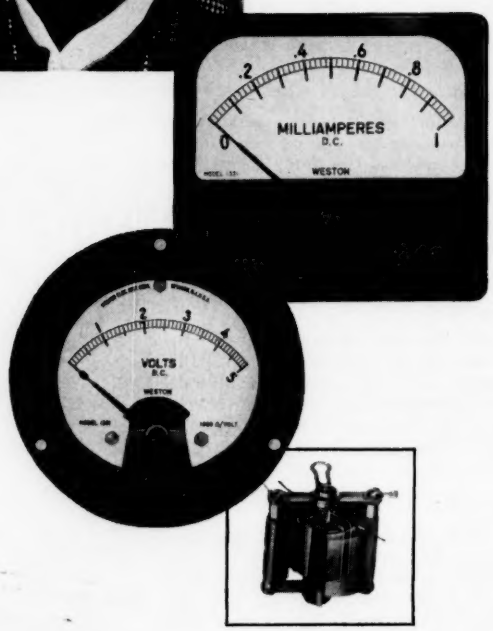
Operate at 200° C! AMPHENOL—the first manufacturer to successfully extrude Teflon dielectric cable and leader in approved RG-/U Teflon cables—presents for the first time Subminax Teflon coaxial cables. Available in five types and in three impedances (50, 75 and 95 ohms), AMPHENOL Subminax cables meet the combined needs of miniaturized high temperature applications. Utilizing both extruded Teflon dielectrics and jackets, these new cables withstand a continuous operating temperature of 200° C, have higher power handling capabilities than corresponding polyethylene types and can be easily soldered under field conditions without "flowing"

RG-/U NO.	AMPHENOL NO.	IMPEDANCE OHMS	O. D. MAX.
187	421-106	75	.110"
188	421-105	50	.110"
195	421-111	95	.155"
196	421-109	50	.080"
—	421-637	75	.150"

Important to users is the fact that AMPHENOL *Subminax Teflon Cables have been engineered to match an existing line of proved RF connectors, consequently reliable Subminax connections.*

AMPHENOL ELECTRONICS CORPORATION
Chicago 50, Illinois

the core magnet makes them so different!



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CORMAG®

PANEL INSTRUMENTS

Weston's core-magnet instrument mechanism *has* made a big difference in panel meters . . . a *big* difference in instrument *reliability, mounting facility,* and *instrument costs.* The core-magnet construction is extremely simple, yet it provides measurement reliability meeting Weston's exacting standards. It is self-shielding, thus permitting the instruments to be used interchangeably on magnetic or non-magnetic panels; as well as mounting close together without intereffect. The final difference is their cost. Due to design simplification, they are yours for *less* than you pay for conventional panel instruments. For complete specifications and prices, consult your nearest Weston representative or write Weston Electrical Instrument Corp., Newark 12, N. J.

A DAYSTROM UNIT

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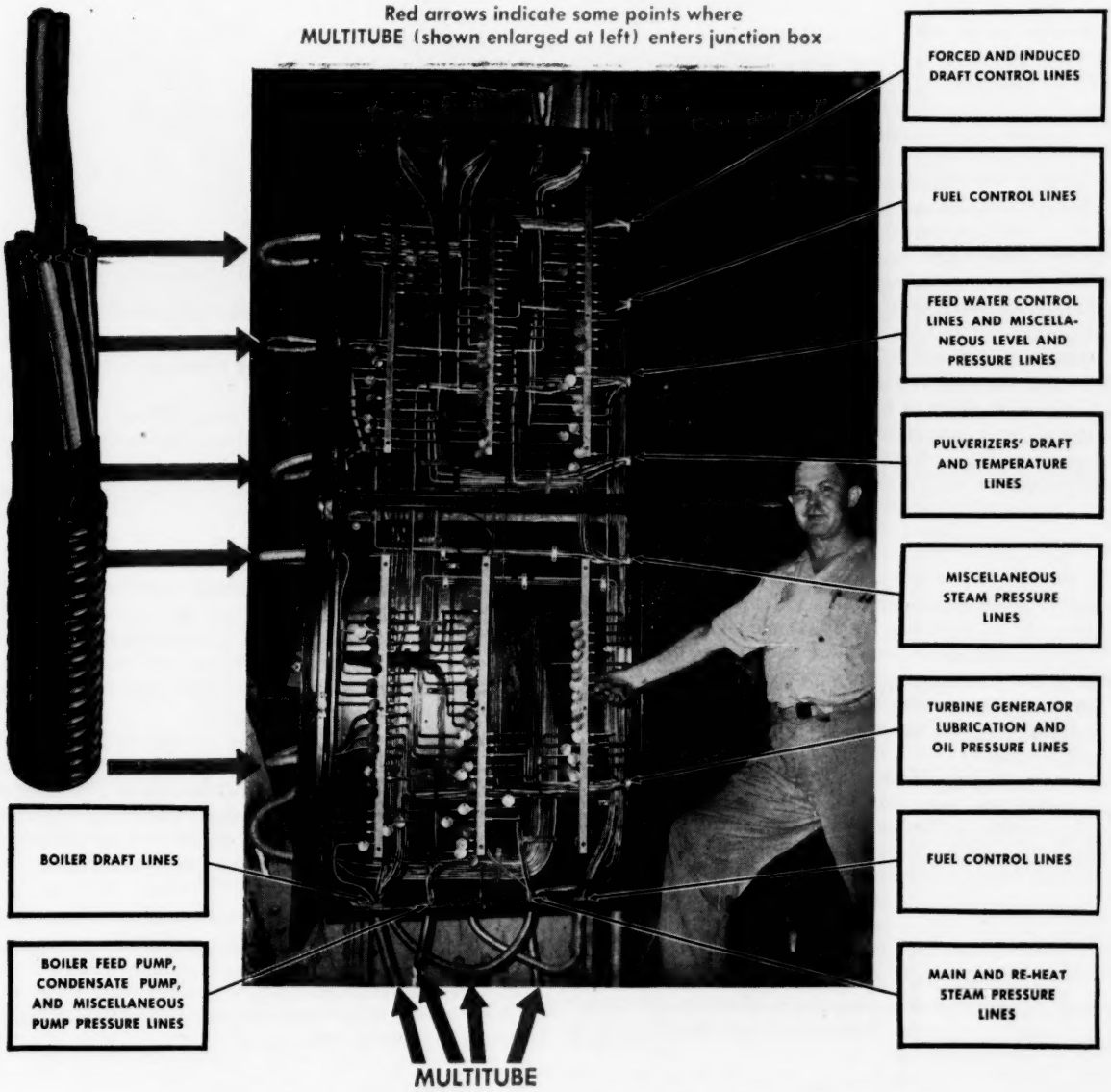
224 Instrument Tubes in 22 Runs Of

CRESCENT ARMORED MULTITUBE

In This Control Board Junction Box

Complete protection at substantially lower installed cost is provided by the 22 Runs of ¼ inch O D copper tubes used in this installation at the Long Island Lighting Co.'s 100,000 K.W. generator, steam turbine and boiler unit.

CRESCENT MULTITUBE* is a group of tubes *spirally cabled* together. The installer doesn't have to handle a number of individual tubes—there is just one unit to work with. This system means fewer connections and fittings, lower cost for supports or racks, ease of mounting, and less space. This product is licensed under U. S. Patent No. 2,578,280.


Red arrows indicate some points where
MULTITUBE (shown enlarged at left) enters junction box
FORCED AND INDUCED DRAFT CONTROL LINES
FUEL CONTROL LINES
FEED WATER CONTROL LINES AND MISCELLANEOUS LEVEL AND PRESSURE LINES
PULVERIZERS' DRAFT AND TEMPERATURE LINES
MISCELLANEOUS STEAM PRESSURE LINES
TURBINE GENERATOR LUBRICATION AND OIL PRESSURE LINES
FUEL CONTROL LINES
MAIN AND RE-HEAT STEAM PRESSURE LINES
BOILER DRAFT LINES
BOILER FEED PUMP, CONDENSATE PUMP, AND MISCELLANEOUS PUMP PRESSURE LINES
MULTITUBE

Send for Technical Bulletin No. 356-A With Complete Engineering Data

CRESCENT INSULATED WIRE & CABLE CO.

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* Reg. Trade Mark

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NONLINEAR CONTROL discussed by *Charles Taylor*

It may seem to be inconceivable that nonlinear control can be applied to complex dynamic processes. Excellent examples of such processes are to be found in the petrochemical industry. Paradoxically, however, nonlinear control is implied if optimum control of such processes is desired. Optimum is defined here in the sense that maximum efficiency, or economy, of plant operation be achieved for specified product quality in the face of changing plant conditions.

Even the word nonlinear has a bewildering connotation. If a system is nonlinear it is frequently assumed that the system transcends human understanding or control. To actually apply nonlinear control to a process (linear or nonlinear) seems further out of the question. A basic reason for this awesome stature is the fact that the familiar tools of linear systems design and analysis no longer apply. The principle of superposition (i. e., the sum of effects being simply related to the sum of causes) is not valid in the nonlinear realm. The mathematical foundations upon which engineering practice may be based are weakened without the generality afforded by the principle of superposition.

To understand why nonlinear control is implied in optimizing processes, it is necessary to appreciate the fact that a linear control system is, by definition, non-adaptive. Once the control parameters have been chosen in a linear system they are fixed (until manually changed). These control parameters may be visualized as weighting coefficients ascribed to the past, present, and future states of the system. The overall dynamic system behavior is determined by summing up these weighted past, present, and possible future system states regardless of the type of inputs or disturbances. In simple single loop-control systems this selection of the control parameters or weighting coefficients of past, present, and future behavior corresponds respectively to choosing the amount of integral, proportional, and derivative control action. This means that, at best, a linear control system must always be a compromise. If the past is heavily weighted, the system will tend to be sluggish. If the present and possible future states of the system are weighted more heavily than the past, the system may be capable of adjusting to sudden changes, or correcting for major disturbances, but there is the danger of erratic, unstable behavior. In practice "middle-of-the-road," or compromise, control parameter values must be chosen.

On the other hand, one form of an adaptive control system will have an ensemble of sets of control parameters from which to choose. The particular set chosen at any instant will depend upon the state of the process variables. The system will continuously switch from one set of parameters to another in order to satisfy an optimizing criterion in terms of maximum efficiency or economy as mentioned above. This type of control system will "learn from experience" and adapt to many different situations. By definition, adaptive control is of necessity nonlinear control.

Dr. Charles F. Taylor discusses nonlinear adaptive control for optimizing processes.

A useful by-product derived from this nonlinear control concept is that system performance becomes nearly independent of process conditions, such as weakening of catalyst activity in a petroleum process. An advantage of nonlinear adaptive control is that a detailed analytical description of the process is not required in order to achieve optimum performance. This benefit is of particular importance in petroleum processing where it is exceedingly difficult to obtain valid transfer functions or analytical models of the processes.

Fortunately, with the advent of reliable digital computers that can be "married" to complex processes, the future for nonlinear adaptive control is bright. Digital techniques are well suited to this method of control since the ensemble of sets of control parameters are finite and discrete. Further, sampling (in time) techniques may be employed.

Enter nonlinear adaptive sampled-data control systems!

By applying the latest proven techniques, our well-qualified staff at Daystrom Systems is prepared to take single responsibility of assembling and installing a system to meet your needs. We are currently compiling a file of new applications and papers on various parts of systems, both industrial and military. If you are interested in receiving the file and periodic additions, please write us.

DAYSTROM SYSTEMS
Division of Daystrom, Inc., 5640 La Jolla Blvd.,
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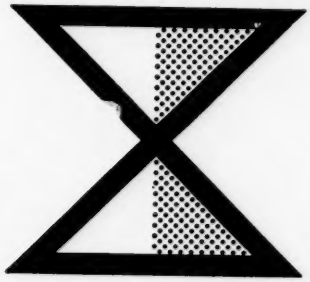
Düsseldorf

November 2nd to 10th, 1957

INTERKAMA



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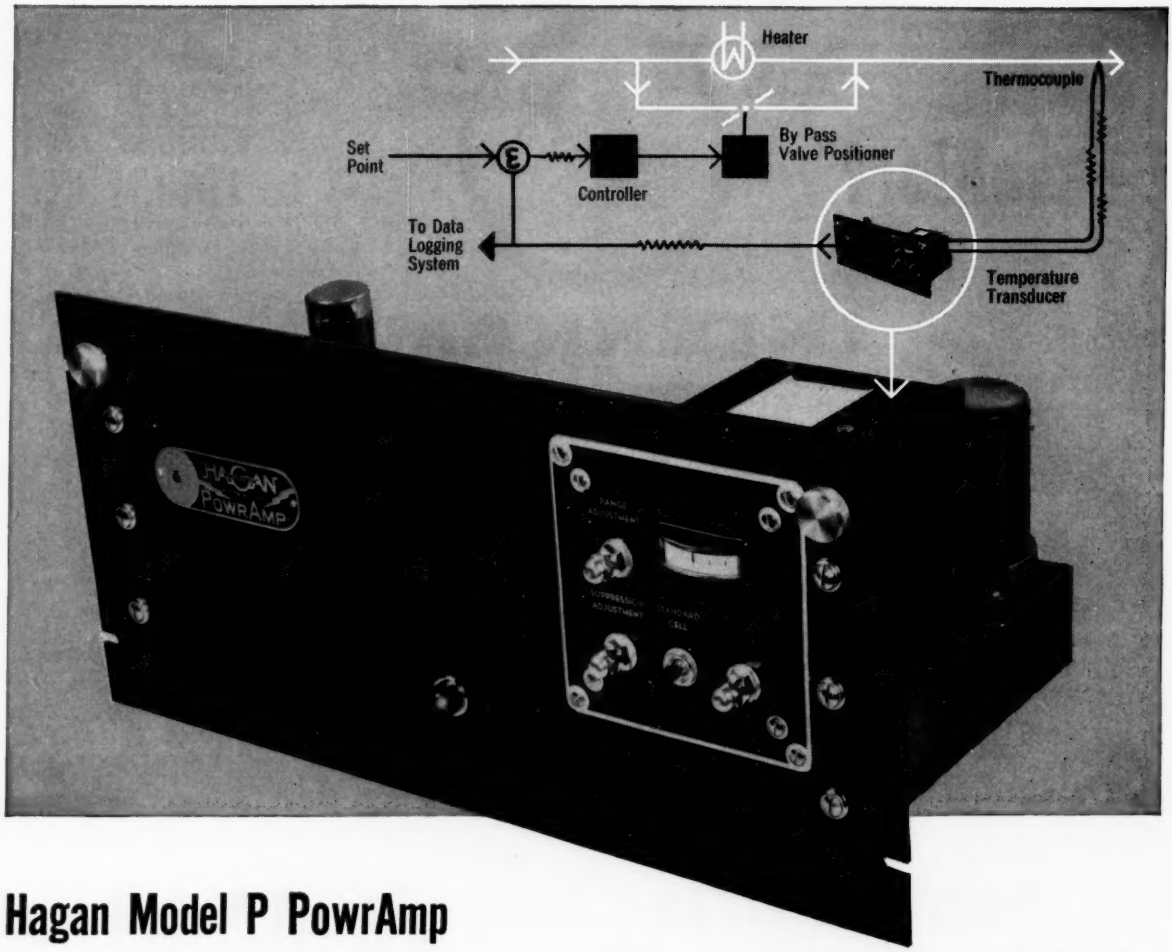


Hagan Model P PowrAmp

. . . a high speed, high accuracy, low input level dc amplifier for TEMPERATURE CONTROL

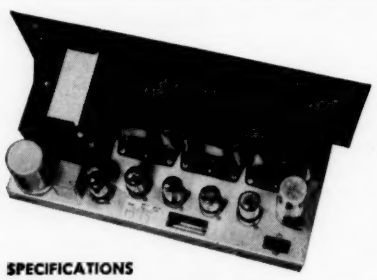
Combining the accuracy and sensitivity of a laboratory instrument with the rugged construction and reliability of industrial equipment, the Hagan Model P PowrAmp is a unique device for the amplification of *any* low level dc voltage.

The Model P is a feedback-stabilized dc amplifier of high stability and high gain. It does not use slidewires or motors, and maintains its fast response even at low inputs. It is particularly suitable as a temperature transducer for control and data logging applications, where speed of response and high sensitivity are important considerations.

Changes in range and zero suppression are accomplished by changing the plug-in input box. The Model P can be utilized in pneumatic control systems by converting its electrical output into a pneumatic signal using the Hagan electro-pneumatic converter.

Hagan PowrAmp transducers are available for most key variables. Electro-hydraulic servo valves and electronic control computers are also available as components or as units in engineered systems.

For additional information, write for the bulletin, "Facts and Features of the Hagan Model P DC Amplifier."



SPECIFICATIONS

Input—0-1 mv and up from sources having source resistances of up to 1000Ω.
Outputs—±30 vdc or ±3 vdc and 60 ma differential current for use in double coil recorders or the Hagan electro-pneumatic converter.
Step Response for full scale output—Better than .1 sec for any input amplitude.
Frequency Response—10 cps regardless of input amplitude.
Overall accuracy—For input ranges 1-5 mv ±.5% full scale voltage range. For input ranges 5 mv up ±.25% full scale voltage range.
Resolution—Better than .001°F when used with IC couples.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES

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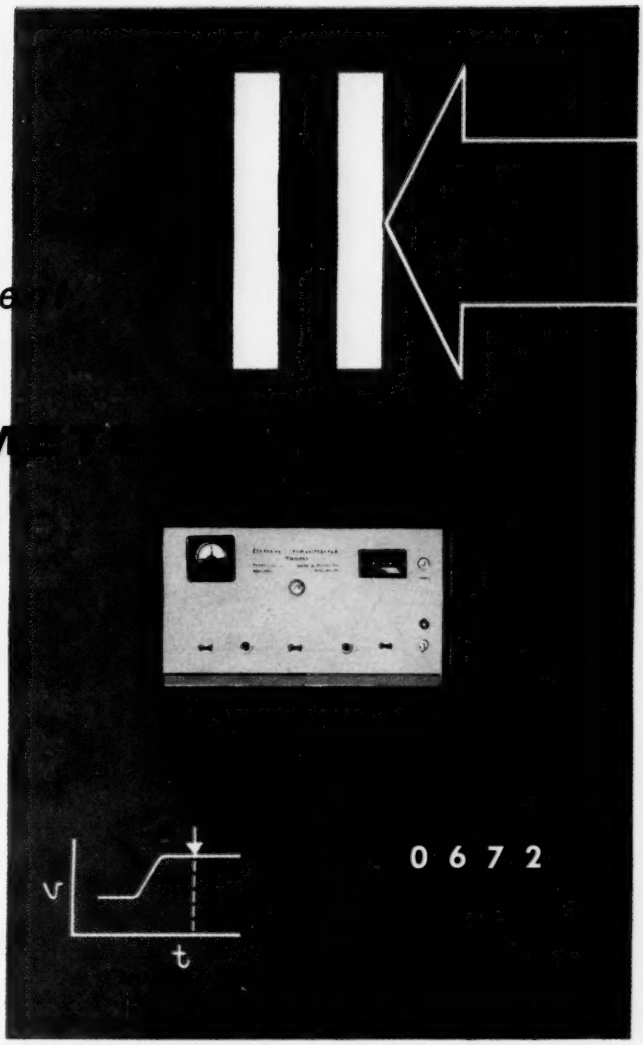
New standard
in pressure measureme

Consolidated's
ELECTROMANOM



SPEED AND VERSATILITY—Now you can get high-accuracy pressure measurements where readings with mercury manometers are impractical. Compact, portable, and ruggedly built, the Consolidated Electromanometer is easy to operate and particularly useful where a large number of pressure measurements are required in a limited period of time...

HIGHEST ACCURACY—Operator error is practically eliminated with a large visual digital readout (registering ±1000 counts full-scale). An electrical analog output is provided for recording or control purposes (±10 volts d-c full scale). Linearity and hysteresis errors on the analog output are less than 0.05% of full scale.

BEFORE YOU INVEST IN ANY SYSTEM, be sure to write for Bulletin CEC 1547-X30, or contact your nearby CEC field office for complete specifications.

Designed for absolute, differential, and gage pressure measurements, CEC's Electromanometer is an electronic null-balance servo-type system consisting of a Pressure Balance and Servo Amplifier assembly with a rapid response time.

MULTI-CHANNEL ADAPTER, fundamentally a switching device, permits the use of up to six different Pressure Head assemblies with a single Servo Amplifier. The Adapter contains all necessary calibrating and balancing controls, and becomes the base for the Servo Amplifier.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

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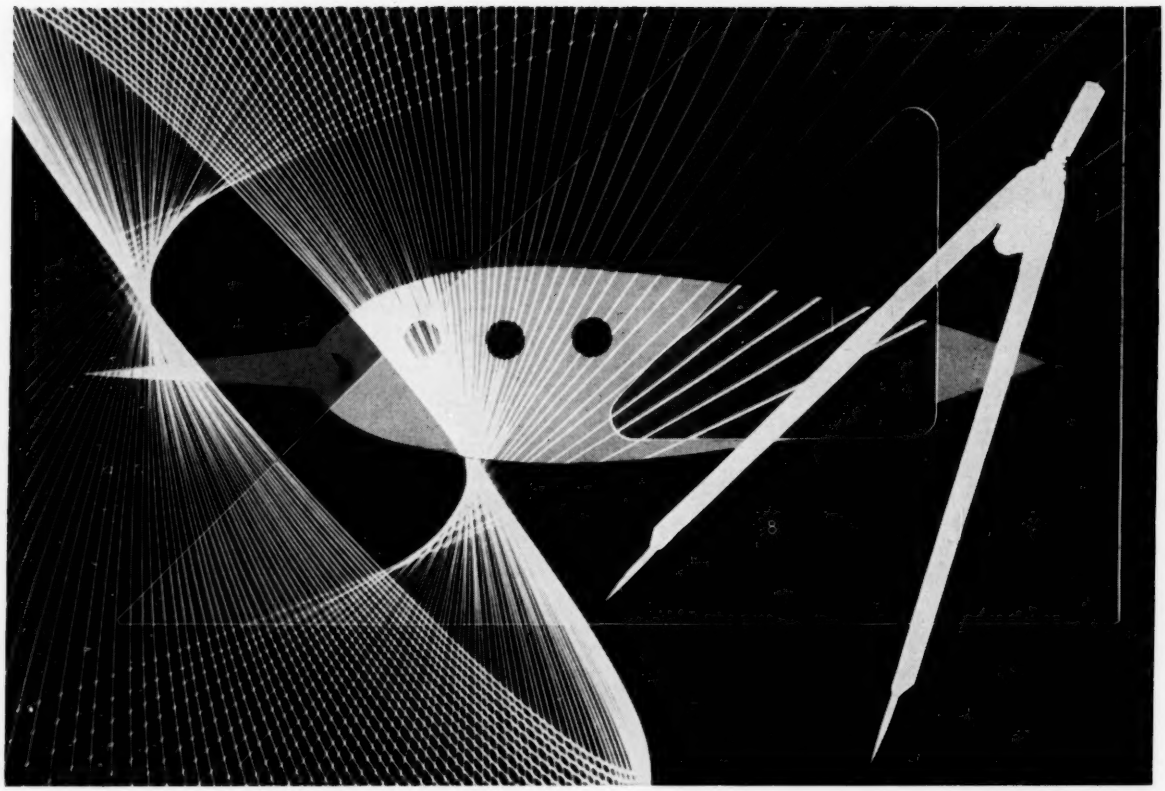


Creative Engineers:

Work where the breakthroughs are being made in every major field of Electro-Mechanics

As a creative engineer, you belong at the front-line of your field . . . where tomorrow's scientific battles are being won . . . where you can help win them.

For more than a decade, AUTONETICS has been at the forefront of electro-mechanical technology . . . building up the unique stockpile of experience and developing the advanced techniques and tools that can make your professional victories possible at AUTONETICS today.

Just a few specific results of AUTONETICS' pioneering are: the MG-4 Fire Control System for NATO's F-86K Sabre Jet; Flight Control elements for the F-100 Super Sabre; *Numill*, a new magnetic-tape controlled machine-tool system capable of performing complex milling and drilling operations automatically; *Recomp I*, a new portable, high-speed, completely transistorized digital computer; and inertial guidance systems for both airplanes and missiles.

Today, our programs are gathering speed, broadening scope. New engineering methods have been developed to cut lead time. System and component evaluation is being accelerated with automatic checkout equipment. Packaging is being designed and systems micro-minaturized to fit the cramped confines of sleek missiles and jets.

YOUR OPPORTUNITY EXISTS AT EVERY LEVEL of creative engineering from Preliminary to Performance Test—because Autonetics is one of the few companies in the world that can design and quantity-produce complete automatic control systems for both the military and industry.

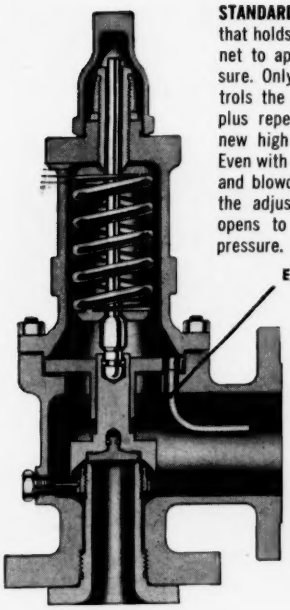
LET US KNOW what kind of creative engineering interests you (please include highlights of your education and experience). Write today to: Mr. A. N. Benning, Administrative and Professional Personnel, Dept. 358-IA-4, AUTONETICS, 9150 E. Imperial Highway, Downey, California.

Assistant Chief Engineer Norman F. Parker joined Autonetics in 1948 after receiving his DSc from the Carnegie Institute of Technology. Dr. Parker has been recognized nationally for his work in Inertial Navigation, and was chosen recently to present a paper on that subject at a NATO conference in Italy.

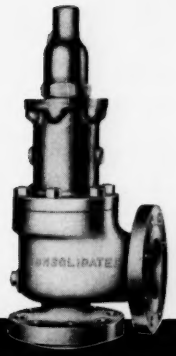
Jack Wittkopf was Associate Professor of Electrical Engineering at Oregon State for 6 years before he joined Autonetics in 1951. Now Group Leader in computers and electronics, Jack lives with his wife and four children in Autonetic's home town of Downey, California, where his spare time activities include photography and ham radio.

Autonetics
A Division of North American Aviation, Inc.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

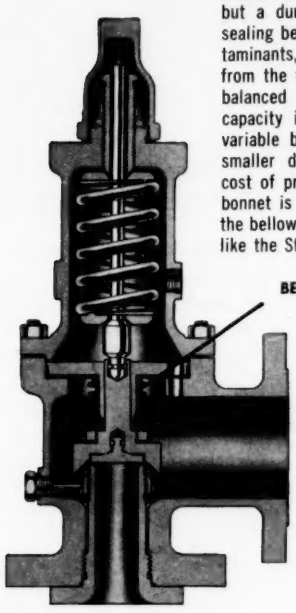


STANDARD VALVE. Note the eductor tube that holds the pressure in the valve bonnet to approximately atmospheric pressure. Only the force of the spring controls the valve. Far better valve action plus repetitive flow capacity assure a new high in operational dependability. Even with repeated popping, set pressure and blowdown are consistent. Whatever the adjusting ring position, the valve opens to full capacity at 10% over-pressure.



LOOK INSIDE

before you buy another safety relief valve



BELLOWS VALVE. Similar to the Standard, but a durable, two-ply stainless steel sealing bellows effectively isolates contaminants, corrosion or viscous fluids from the working parts. The bellows is balanced with the seating surface — capacity is less seriously affected by variable back pressure, so the use of smaller discharge piping reduces the cost of pressure-relieving systems. The bonnet is vented to the atmosphere. If the bellows ruptures, the valve operates like the Standard valve.

CERTIFIED AND APPROVED. Both Standard and Bellows Valves are approved under ASME Unfired Pressure Vessel Codes and are certified by the National Board of Boiler and Pressure Vessel Inspectors.

LOOK INSIDE the Consolidated Safety Relief Valve. Fewer functional parts and precision machining and alignment of parts assure long valve life and less maintenance. Economical "2 in 1" design permits the Standard valve to be converted to the Bellows type right in your own shop.

There is only one adjusting ring—it can be set easily *before* valve installation to obtain peak performance at 4-5% blowdown. *Full-rated relieving capacity* is certain at all positions of the ring because a fixed maximum secondary orifice provides full lift at 10% over-pressure. *Valve action is consistently positive* even where "superimposed" back pressure is in the relieving system.

The temperature-compensating disc eliminates seat distortion caused by temperature-induced stresses — always seats tightly even when reasonable strains of unanchored discharge piping are present. A minimum guiding area is provided to align the seating surfaces — less chance of a sticking disc holder when corrosion or contamination build up on the guiding surfaces. The seating surfaces are optically-ground flat for easier, more economical servicing.

The contours of the huddling chamber and secondary orifice take full advantage of the stream pressure and kinetic forces. No other valve has this safety feature. Note the low placement of the threaded section that holds the nozzle in the valve. It assures high resistance to discharge piping strains — no leakage resulting from strain induced into the nozzle.

BE SURE OF ABSOLUTE PROTECTION for personnel and equipment — plus low maintenance. Select Consolidated Safety Relief Valves. Full range of sizes and pressures available with standardized inlet and outlet face-to-face dimensions for easy interchangeability with the valves of some other manufacturers. *Write for Catalog 1900.*

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.*

CONSOLIDATED SAFETY RELIEF VALVES

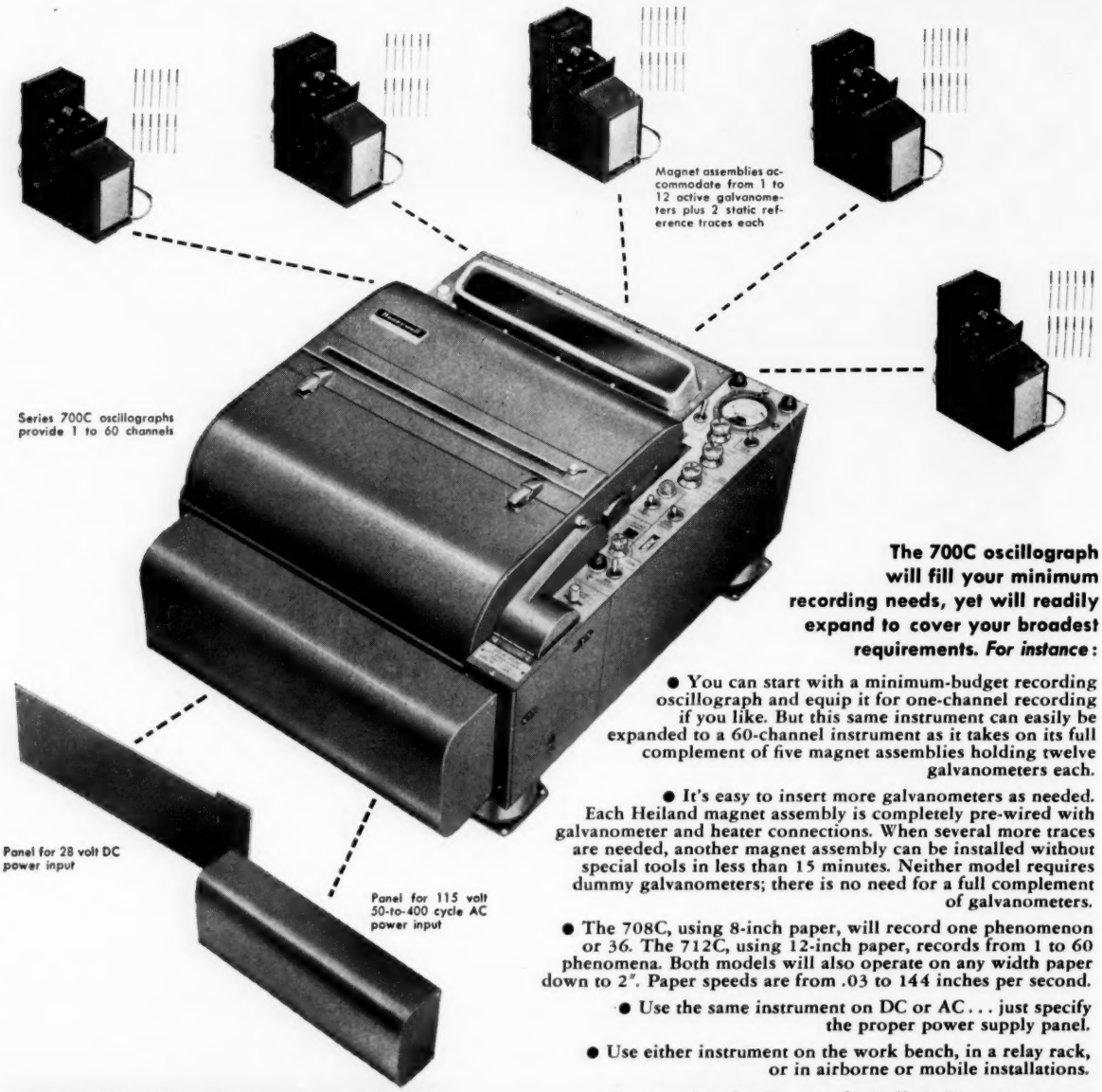
A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **58** on inquiry card.

expand your oscillograph capacity as your needs demand...

with the HEILAND Series 700C Recording Oscillograph


Magnet assemblies accommodate from 1 to 12 active galvanometers plus 2 static reference traces each
Series 700C oscillographs provide 1 to 60 channels
Panel for 28 volt DC power input
Panel for 115 volt 50-to-400 cycle AC power input

The 700C oscillograph will fill your minimum recording needs, yet will readily expand to cover your broadest requirements. *For instance*:

- You can start with a minimum-budget recording oscillograph and equip it for one-channel recording if you like. But this same instrument can easily be expanded to a 60-channel instrument as it takes on its full complement of five magnet assemblies holding twelve galvanometers each.
- It's easy to insert more galvanometers as needed. Each Heiland magnet assembly is completely pre-wired with galvanometer and heater connections. When several more traces are needed, another magnet assembly can be installed without special tools in less than 15 minutes. Neither model requires dummy galvanometers; there is no need for a full complement of galvanometers.
- The 708C, using 8-inch paper, will record one phenomenon or 36. The 712C, using 12-inch paper, records from 1 to 60 phenomena. Both models will also operate on any width paper down to 2". Paper speeds are from .03 to 144 inches per second.
- Use the same instrument on DC or AC... just specify the proper power supply panel.
- Use either instrument on the work bench, in a relay rack, or in airborne or mobile installations.

For complete details, write for Bulletin No. 700-EA

MINNEAPOLIS **Honeywell**

Heiland INSTRUMENTS

5200 E. EVANS AVE., DENVER 22, COLORADO

SALES—SERVICE FACILITIES AROUND THE WORLD

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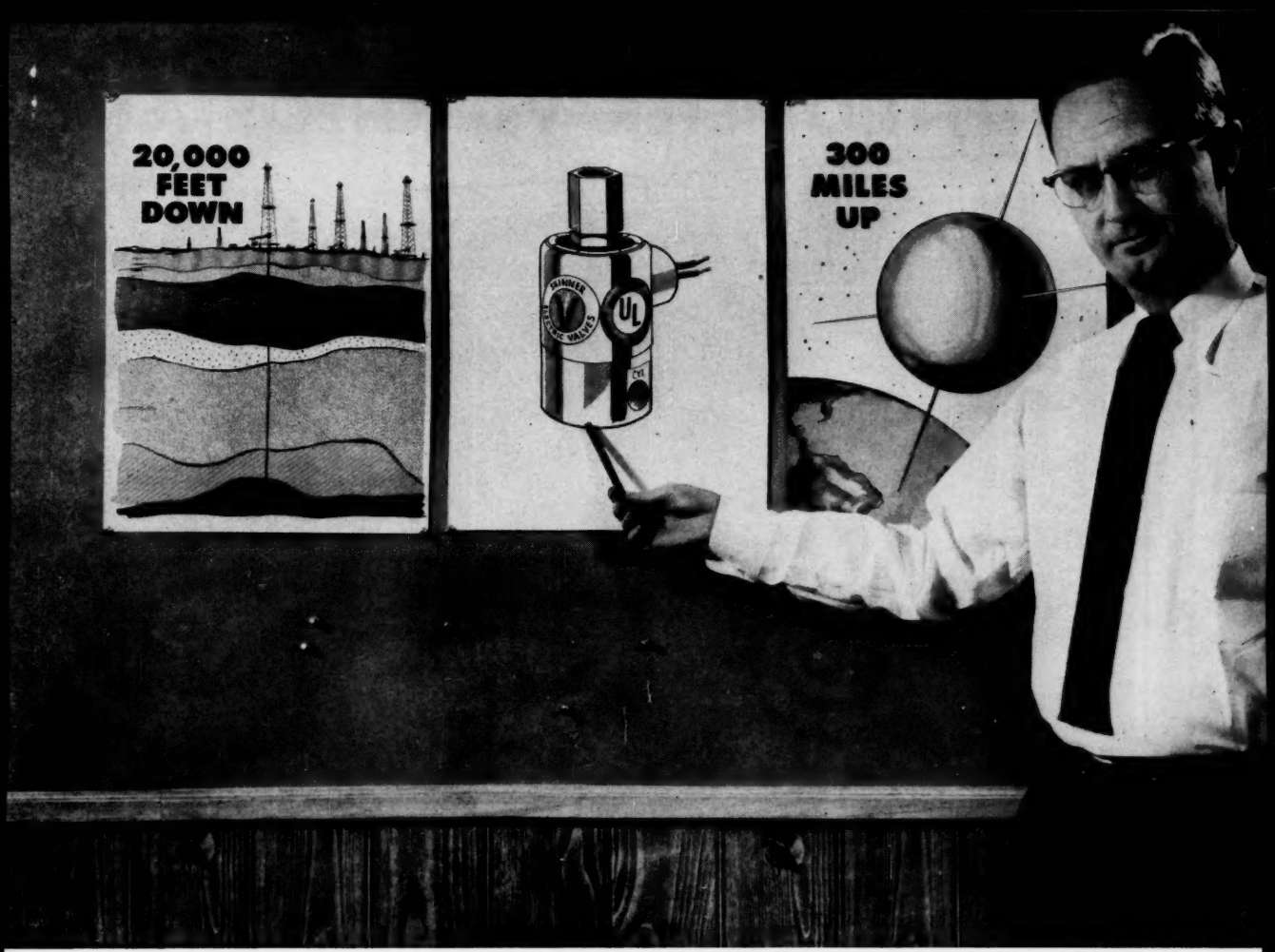
Circle **35** on inquiry card. ⟶



The versatile design of Skinner Solenoid Valves makes their applications almost unlimited

Skinner Solenoid Valves have such great versatility that no one, not even their makers, knows the full extent of their applications. The range of their extremes demonstrates this vividly. One Skinner valve is being used in an instrument in Texas oil wells that tells the nature of earth strata 20,000 feet below the surface. Another one will be used to help launch the satellite that soon will be circling the globe.

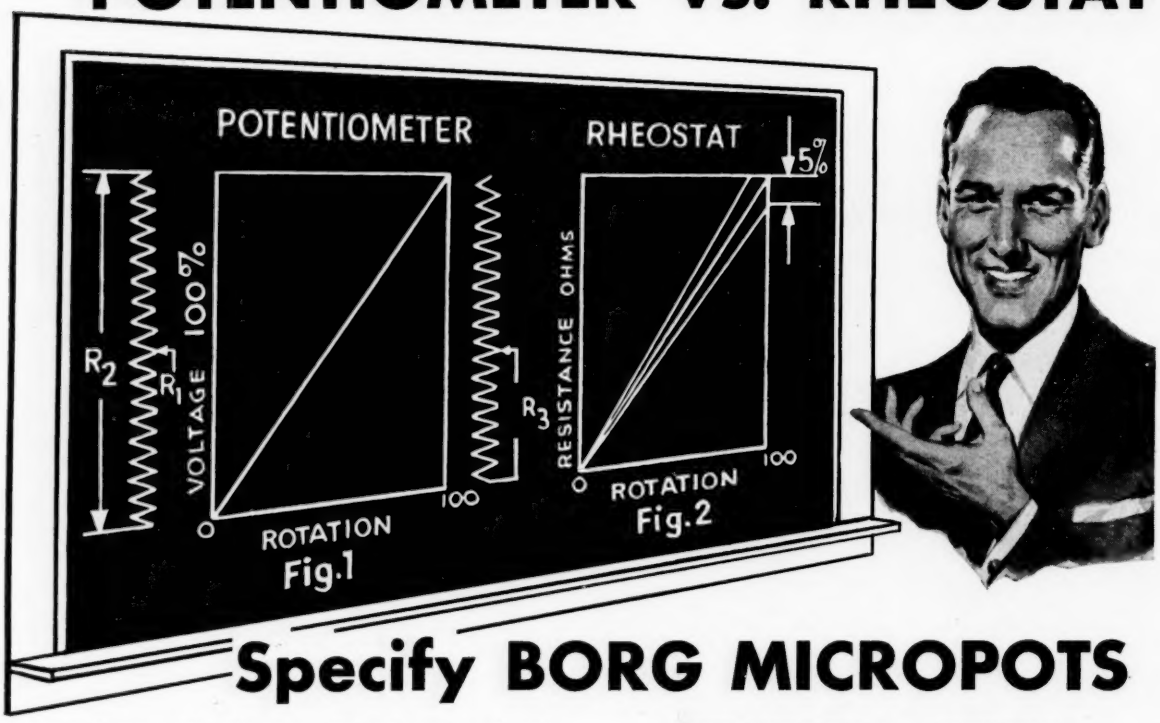
If you have a problem that a solenoid valve might conceivably solve, we urge you to talk to a Skinner representative. Fill him in on the nature of your application. He'll be glad to work with you in selecting a valve that matches your requirements as to port sizes and locations, voltages, pressures, temperature conditions, flow adjustments and mountings.

For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 414.

Skinner Solenoid Valves are distributed nationally

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN
CONNECTICUT

POTENTIOMETER Vs. RHEOSTAT



Specify BORG MICROPOTS

Potentiometer Vs. Rheostat. Potentiometers should be used whenever possible to reduce systems error and excessive cost. Here's why.

POTENTIOMETER as a POTENTIOMETER

Definition: A potentiometer is a voltage divider.

Accuracy — Potentiometer accuracy is determined by the ratio of R_1 to R_2 for any given position of the control shaft (Fig. 1). Potentiometer accuracy is *independent* of total resistance. Commercial precision potentiometers are designed for use as voltage dividers. Therefore, the total resistance is $\pm$ 5%. However, the output voltage is the ratio of R_1 to R_2 and provides a linearity accuracy of 0.1% (Fig. 1). Linearity accuracy in commercial precision potentiometers is 0.1%.

POTENTIOMETER as a RHEOSTAT

Definition: A rheostat is a variable current control.

Accuracy — When used as a rheostat (2 wire hook-up) the accuracy of the potentiometer is determined by the absolute resistance R_3 for any given position of the control shaft (Fig. 2).

Rheostat accuracy is *dependent* upon the absolute resistance at any point.

Commercial precision potentiometers, when used as rheostats, have an absolute ohmic resistance R_3. It may deviate from zero to 5% from theoretical over the range of zero to 100% of shaft rotation (Fig. 2). Errors in distribution of this resistance (comparable to potentiometer linearity tolerance) must be added to this error to ascertain the "total ohms per degree conformity", the true measure of rheostat accuracy.

Consider the possibility of a closer total resistance tolerance to provide greater accuracy when used as rheostats. Commercial tolerance on fixed resistance is 5% with special selected values to 1%. This selected accuracy, if duplicated in a rheostat, would still be 10 times greater than the standard 0.1% accuracy of the commercial potentiometer. Factors which contribute to the difficulty in tight total resistance tolerances in fixed resistors are: resistance stability, temperature coefficient, and the absolute ohmic value of commercially available resistance alloys.

These limiting factors apply to potentiometers used as rheostats. This increases the cost of such units just as the cost of tight tolerance fixed resistors is considerably greater than standard tolerances.

We have found, through years of building potentiometers, designing equipment and in consultation with customers, that when systems can be designed to use potentiometers in place of rheostats, greatly increased accuracy results and usually the cost is reduced.

Write for Complete Engineering Data • CATALOG BED-A56

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

ELECTRONIC — MECHANICAL BORG EQUIPMENT — Built by Borg

For more information circle **62** on inquiry card.

SALES MANAGERS: You route this memo—

to your ad department and agency—reminding them to plan now to advertise in the 1958 I&A Handbook & Buyers' Guide

Industry's only instrument-control equipment buying directory, the Guide offers you . . .

- Entree to 23,000 buyers of instrument and automatic control equipment.
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Reserve your ad space now. Forms close August 15-31—write:

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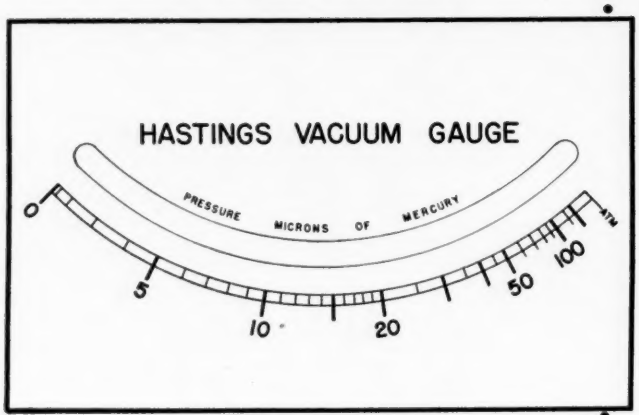
HASTINGS VACUUM GAUGES

FOR

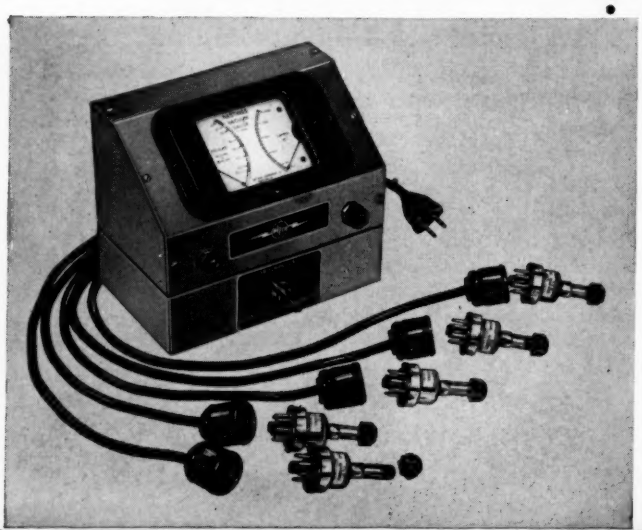
Highest Accuracy

- **STABLE PERFORMANCE**
- **RAPID RESPONSE**
- **EASY TO USE**

Model GV 23



Model GV 23 vacuum scale shown actual size



NEW!

HASTINGS MODEL GV-23—VACUUM GAUGE

Highest accuracy in 0 to 100 micron range. Direct reading without adjustments. Mirror scale with knife edge pointer for accurate reading. Internal voltage regulator takes care of fluctuations in line voltage. Gauge tubes incorporate Hastings patented principle of noble metal compensated thermopiles for greater stability, longer life, more accurate reading. Rapid response in leak detection.

EASY TO READ: Operator can read vacuum directly! EXTRA SENSITIVE in 0-100 micron range!

SIMPLE TO USE: Enables less experienced personnel to take more accurate readings!

HASTINGS MODEL GV-3 VACUUM GAUGE

Measures 0-1000 micron range with high accuracy. Stable calibration. Current set device allows use with any line frequency, or with unmatched gauge tubes. Low in cost but has all advantages of ruggedness, and accuracy. Available with or without five position switching attachment shown.

For the 0.1-20 mm. range, inquire about Hastings absolute pressure indicator.

LABORATORY ACCURACY UNDER INDUSTRIAL PRODUCTION CONDITIONS!

FOR MORE DETAILED INFORMATION WRITE:

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L. K. Edwards (center), head of the Advanced Design and Systems Analysis Department, discusses atmosphere effects on missile guidance with W. F. Wright (right), head of the Analysis, Plans and Reports Section, and A. L. Lowell, Advanced Design Staff Engineer.

MISSILE SYSTEMS ANALYSIS—*a field of varied assignments*

Engineers and scientists seeking a wide range of assignments will be interested in Lockheed Missile Systems Division's concept of systems analysis. For at Lockheed, systems analysis responsibilities involve virtually every phase of missile preliminary design and development. Essentially, engineers and scientists in this department formulate overall analytical treatment; perform original analyses when problems defy conventional handling; coordinate analytical activities among different departments.

Present openings are in areas related to inertial guidance, functional systems, power plants, control systems and overall weapon configuration. Openings are at Sunnyvale and Van Nuys Engineering Centers.

Inquiries are invited from engineers and scientists whose ability and aptitude demand a wide range of assignments.

Lockheed

MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION

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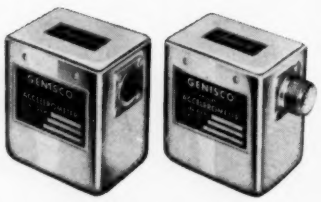
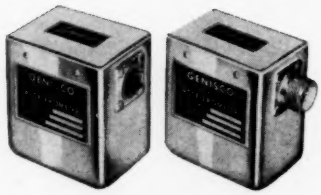


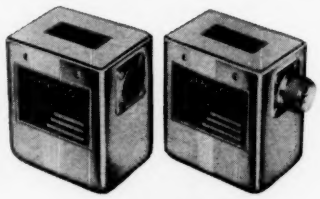
Model GLH

A rugged magnetically damped instrument with low natural frequencies for low range. High-quantity production assures good price and delivery schedules. Available in ranges from ±1 G to ±30 G.



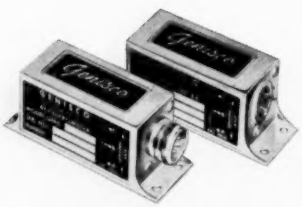
Model DDL

Magnetically damped low-range instrument available in ranges from ±1 G to ±30 G. Ultra-sensitive models supplied as low as ±0.1 G. Certified to MIL-E-5400 and MIL-E-5272A. Especially good in severe shock and vibration applications. An acceleration-sensitive switch version of the DDL is designated as the Model DDS.



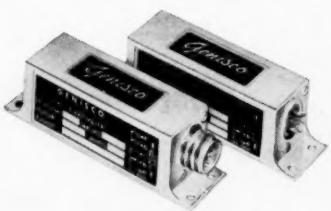
Model GAL

Incorporates a variable transformer a-c output with the magnetically damped sensory mechanism of the proven Models DDL and GLH. Superior reliability, life, resolution, and sensitivity. Available in ranges from ±1 G to ±30 G. Range as low as ±0.1 G also obtainable.



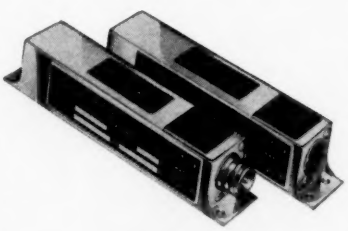
Model GMO

A rugged, miniature, viscous-damped instrument with ranges from ±2 G to ±30 G. Unbalanced-range instruments also available. Medium high natural frequencies.



Model GMT

Basically a Model GMO with internal thermostat-operated heater, assuring maximum environmental stability within the instrument. Damping remains constant with change in ambient temperature.



Model GDM

Miniature double-potentiometer instrument capable of sensing lateral acceleration in two mutually perpendicular planes (e.g., pitch and yaw). Ideally suited for missile and high-speed aircraft flight control systems.

NEW! GENISCO ACCELEROMETERS NOW GOLD PLATED FOR GREATER RELIABILITY

CASES GOLD PLATED INSIDE AND OUT—This new trend in instrument plating has two important advantages over tin plating or fusing. Being the least active metal, gold prevents the formation of crystalline "whiskers" inside the case which could reduce performance and even cause malfunction. Gold plating also assures positive protection against corrosion to the exterior of the case and, because of its excellent solderability, makes possible a more reliable hermetic seal. The new gold plating is available on *all* models at *no extra cost.*

Descriptive data sheets available on all models.
Please send request on company letterhead.

Genisco INCORPORATED

2233 Federal Avenue
Los Angeles 64, California

For more information circle **64** on inquiry card.

Facts about **STABILINE®** *Automatic* **Voltage Regulators**

STABILINE type IE (Instantaneous Electronic) is available in 115 volt units — input range from 95-135v. and 230 volt units — input range from 195-255v. STABILINE type IE5101R shown above.

"Here's how to Build-in Automatic Voltage Regulation"

"No matter how good your control instrumentation is, it is not going to be precisely accurate at all times unless the input voltage is precisely *constant.*

"You just can't get better automatic voltage regulation equipment than with this STABILINE. At no load, full load or any intermediate stage it maintains constant *output* voltage regardless of line fluctuations.

"This sensitive, yet ruggedly constructed, automatic voltage regulator is a must component in today's voltage sensitive apparatus."

Three types of STABILINES are available for individual needs:

Type IE (*Instantaneous Electronic*) is completely electronic, instantaneous in action, with no moving parts. Constant output voltage is maintained regardless of line or load fluctuations.

Type EM (*Electro Mechanical*) has zero waveform distortion. Insensitive to magnitude and power factor of the load. Highly efficient.

Type TM (*Tubeless Magnetic*) has no moving parts . . . no tubes . . . no transistors. Ideal for unattended locations or where failure can never be tolerated.

Be sure to see SUPERIOR ELECTRIC'S Mobile Display when it is in your area

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THE SUPERIOR ELECTRIC COMPANY
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Please send STABILINE Bulletin S657 ☐
Have your representative call ☐

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City ..... *Zone* ..... *State* .....

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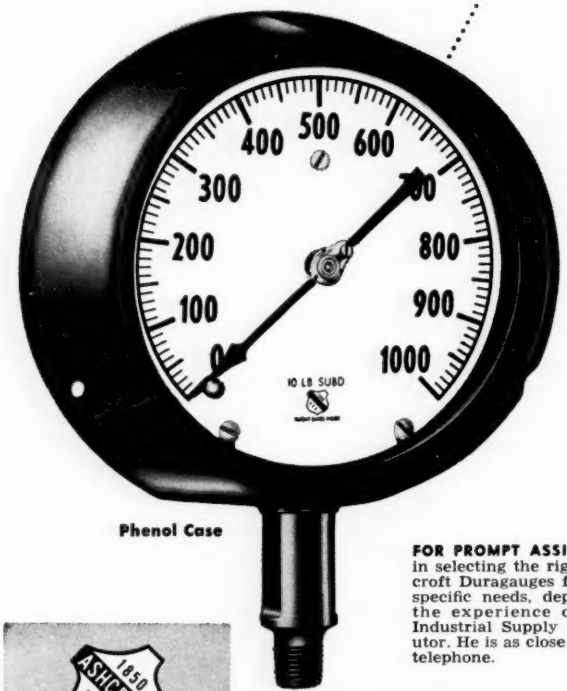
Alumalife® Case



Phenol Case

Why do ASHCROFT DURAGAUGE CASES increase service life?

Duragauge casings add extra-long service life to Duragauges because they're available in three different materials: you can choose the case-material that stands up best in *your application.* You have a choice of *Alumalife®* – a special aluminum alloy; *Cast Iron,* rugged and durable; and *Phenol,* a tough, rigid plastic.

Duragauge casings are dust and moistureproof. Chrome-plated, die-cast retaining rings keep the dial cover glass tightly in position and prevent the entrance of dirt or harmful fumes. Depending upon material, casings are Bonderized and the ring is Anodized and dichromate sealed for protection from corrosion.

For added protection, there is the Maxisafe Duragauge casing with a solid front – a special design for maximum safety and ease of maintenance. Duragauges are easy to service since Duragauge casings are constructed so that the entire system – socket, tube, tip, movement, dial and pointer–can easily be removed as a unit.

Lifetime Duragauge cases are available for numerous dial sizes. You have a choice of Bourdon tube materials, a wide range of pressures, and a movement made completely of stainless steel or stainless steel with nylon bearings and pinion gear.

Whatever case material and gauge system is best for your needs, you can rely on the Ashcroft Duragauge for highest sustained accuracy and long service life.

FOR PROMPT ASSISTANCE in selecting the right Ashcroft Duragauges for your specific needs, depend on the experience of your Industrial Supply Distributor. He is as close as your telephone.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

G4-56

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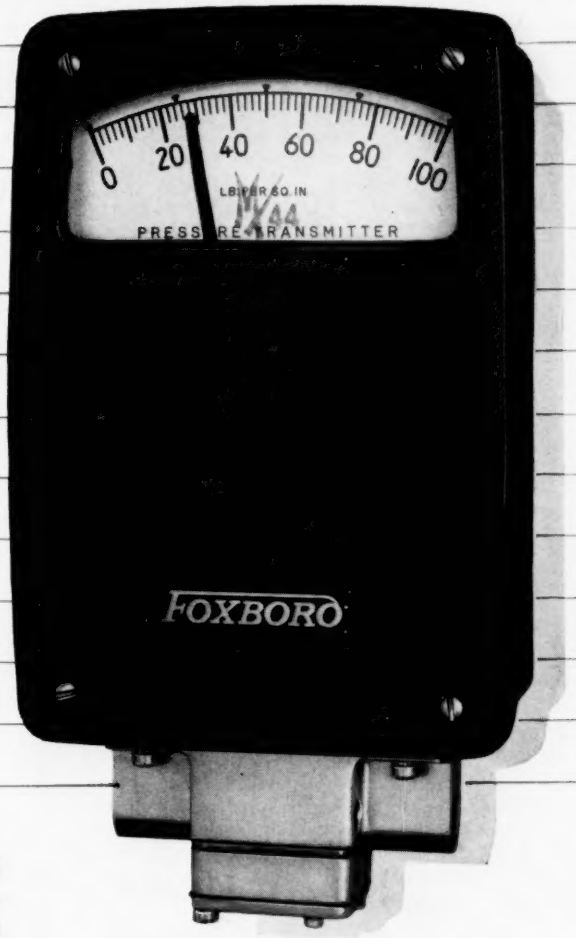
Unique combination of fine engineering and economy!

...the new FOXBORO M/44 INDICATING PRESSURE TRANSMITTER



- **Easier to Read . . . large indicator scale, visible at 20 ft.**
- **Easier to Calibrate . . . simple adjustments "on location"**
- **More Compact . . . single, integral instrument**

Any way you look at it, the new Foxboro M/44 Pneumatic Pressure Transmitter gives you an unmatched combination of fine engineering and economy. First; because it *is* an engineered instrument. There are no attachments or "makeshifts". Second; because it utilizes standard Foxboro parts throughout—parts which have been performance-proved in thousands of successful installations of other Foxboro Instruments. And this means not only top performance, but easier servicing and stocking as well. Third; calibration is simple, right in the field, because the M/44 is "convenience-designed" by men with years of experience in every phase of instrument design and application.

In appearance, too, the M/44 has unmistakable Foxboro quality. Features like the high-legibility indicator scale, the compact drawn-steel case with tough polyester plastic cover. It's the neat, high-efficiency, low-cost pressure transmitter for centralized operation or control. All standard ranges.

Write for complete details

THE FOXBORO COMPANY

464 Neponset Avenue, Foxboro, Mass.

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

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INSTRUMENTATION FOR INDUSTRY

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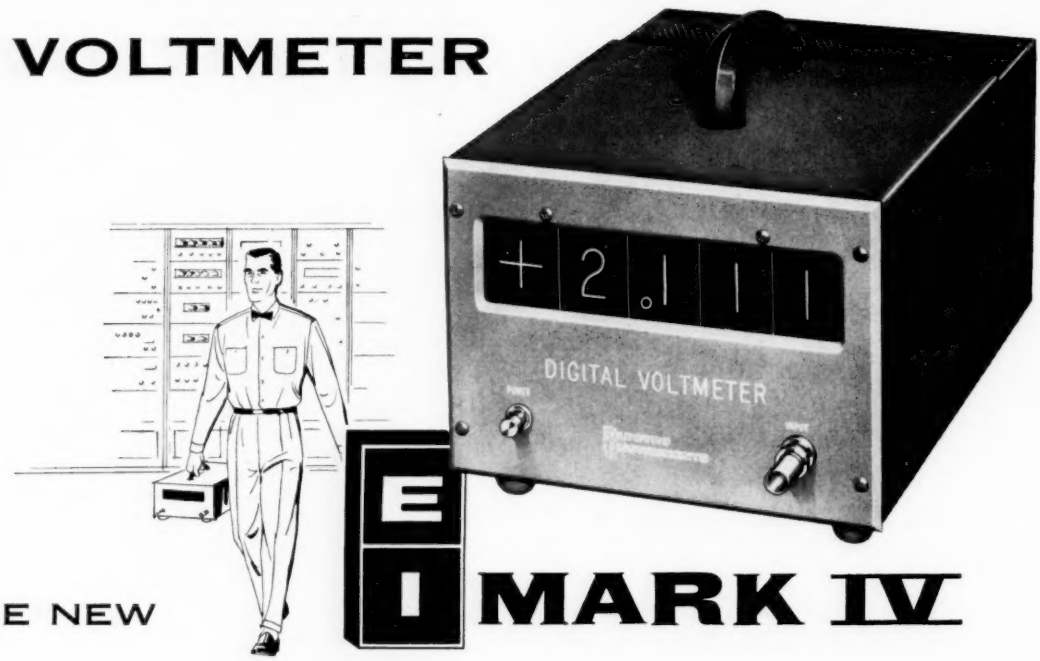
NOW! A PORTABLE, PRECISION DIGITAL VOLTMETER



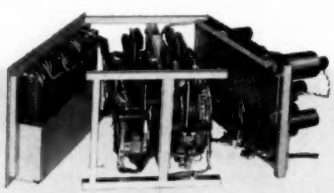
THE NEW E-I MARK IV

This newest E-I instrument provides the perfect general-purpose voltmeter for both laboratory and field use.

Operation is completely foolproof; no manual adjustments or calibrations are required. Measurements are made automatically and results presented digitally with easy-to-read, 1"-high numerals, arranged in line.

A new electronic amplifier design (reducing the number of tubes to only eight!) and advanced miniaturization techniques have reduced the overall size of the new Mark IV to only 7½"x9"x11", and cut the weight to 28 pounds.

Ask your local E-I representative to give you the complete story, or write direct for our new brochure.



UNUSUALLY EASY TO SERVICE

The one-piece hood houses three distinct sub-assemblies: amplifier, power and reference supplies; balance circuit; and read-out. Each sub-assembly is pivoted for excellent accessibility to all parts.

SPECIFICATIONS

Display: four digits, polarity, decimal point.
Range: 0.001-999.9 volts dc.
Ranging: automatic.
Polarity: automatic.
Accuracy: 0.05%, ±1 digit.
Input impedance: 11 megohms.
Average balance time: 1 second.
Calibration: self-calibrated.
Stability: 0.003%/C°.

The complete line of digital instruments

ELECTRO INSTRUMENTS INC.
3794 Rosecrans Street, San Diego, California

For more information circle **68** on inquiry card.

For Complex Fluid Control Problems . . .

Specify The New SPLIT BODY

Super 70 *series*

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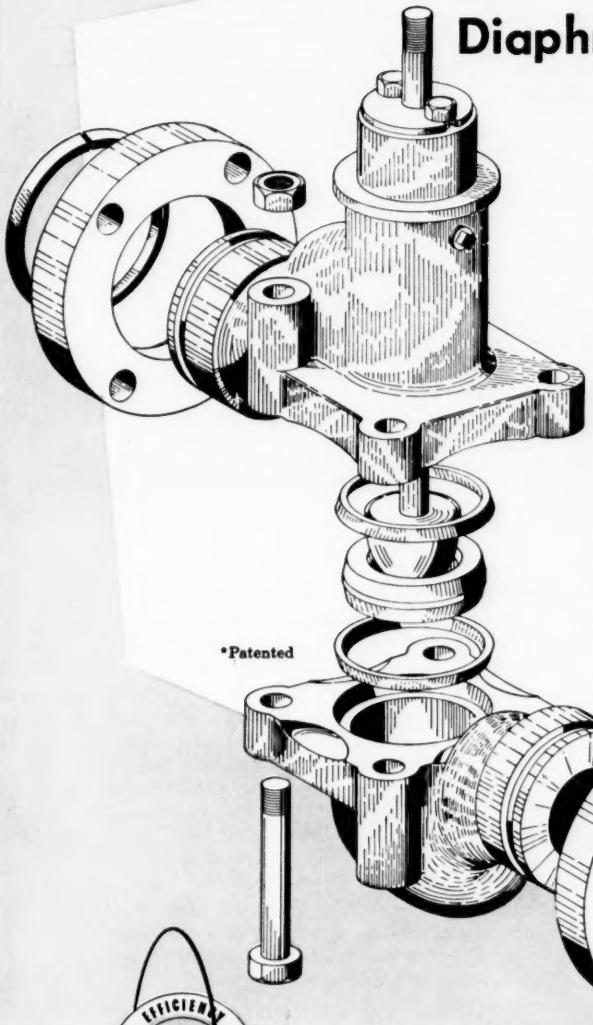

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FEATURES

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on cooling tower pH

Deep in the interior of a giant cooling tower visibility is obscured by shadows, and haze that's actually cooling water, falling like rain down into the tower basin, where it's collected and recirculated to the condensers.

Keeping this water at optimum pH, when it collects in the basin, was once a difficult problem. But the application of practical engineering principles, resulting in the baffle-lined distributing trough and regulated reagent feed shown here, plus L&N's pH Controllability Analysis, offers a new and successful solution to this problem.

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We'll be glad to send you details on the "inside story" of tower pH. Write Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa., for Process Data Sheet 700(1).

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INSTRUMENTS and AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—*M. H. Aronson*, Editor

Editorial

IRE Show Highlights—

Military–Medicine–Miniaturization

EVERY field of modern technology is now producing new and exciting developments at a rate of developments/day; the electronics industry is no exception. The biggest electronics show in the world, the 45th Annual IRE Show, had hundreds and hundreds of new products, new components, new systems—and even a few new concepts (unlike equipments, concepts cannot be mass produced).

The statistics reflect the mammoth size of this event (exhibitors—840 on four giant floors of the New York Coliseum; papers—280 in 55 sessions; equipment on display—nearly 20,000 pieces valued at $10 million; attendance—more than 50,000), and also emphasize its basic problem—no one man can hope to even do a fair sampling job. The time is here when a fresh look is needed at the problem of information delivery via technical papers and exhibits. There is growing need for information specialists, survey briefings, and other techniques that might optimize the education process at the modern trade show. But more about this later—let us now review the impressions of your editors at this giant exhibit and conference.

Impressions

The impact of $50 billion federal expenditures on military purposes was everywhere in evidence—the electronics industry is fat and happy; everybody is having a grand and busy time. And busy it is—the pressure of the vigorous requirements for components in programs such as the guided-missile program is giving impetus to exciting new products and components—even concepts. The major emphasis at the show, at the equipment level, was on components and circuitry, particularly printed circuitry, solid-state circuitry, and miniature components. Perhaps because of the huge numbers of such exhibits, the conventional consumer items—audio, radio, black-and white TV, color TV, and industrial instrumentation—seemed small by comparison. Even the test instrumentation seemed to be aimed at the military market, with large numbers of pulse test equipments being introduced.

Instruments

A brief sampling and listing of the new instruments disclosed at the show illustrates the trends in equipment design. (For more information on any items, circle the inquiry-card number given at the end of each description.)

NRC Equipment Corp. unveiled the new Model 4902 leak detectors, which approach the mass spec in sensitivity at one fourth the price. Principle is basic one of halogen gas emitting ions when striking a hot surface—but drift problem, basic disadvantage to date, has been overcome by use of a differentiating circuit so that instrument responds only to rapid changes, thus reducing drift. **601**

Dumont disclosed the Type 410 oscilloscope with range from dc to above 50 Mc; sweep speeds to 250 kc; pulse rise time of 7 milli-micro-seconds. Also the "most sensitive commercial oscilloscope," the Type 403, with full-scale amplitude measuring range from

EDITORIAL—CONTINUED

1 mv to 500 v in 17 steps; and capable of resolving a 20-microvolt signal. Also introduced was the Type 405 vtvm with 100-mv full-scale sensitivity plus dual and differential inputs. 602

Cubic Corporation introduced the OREAD (Opticle Rotational Encoder, Analog-Decimal), featuring resolution of 1 part in 20,000. 603

Kay Electric Co. revealed a complete line of transistorized test instruments—oscillators, amplifiers, vtvm, etc. 604

Librascope unveiled a new punched-card converter. 605

Magnetic Amplifiers, Inc., unveiled a magnetic amplifier for controlling hydraulic servo valves, featuring power gain of 10^5, and with a time constant of only 4 milliseconds (obtained by use of 5000-cps supply frequency). Also unveiled was magnetic-amplifier-type variable-speed drives for frac-hp motors. 606

Jerrold Electronics unveiled a sweep generator that covers 0.2 to 1000 Mc, and with sweep widths up to 300 Mc. 607

Corning Glass Works unveiled a new line of miniature level switches using an electrolyte with less mass than mercury. 608

General Precision Lab., Inc. unveiled a TV projection system that makes it possible for hundreds to see the receiver picture, bringing the receiving end at last up to the point of development of the transmitting end. 609

Midwestern Instruments unveiled the "730" airborne magnetic tape recorder. 610

Power Designs, Inc., unveiled a CU-2T control unit for power supplies that tracks any two regulated power supplies so that the output is regulated to 0.01% ...611

Keithley Instruments unveiled a new transistorized electrometer and five new micro-micromammeters (down to 10^{-13} amp). 612

F. L. Moseley Co. displayed a new multichannel tape-controlled X-Y recorder; also a time base drive that converts any X-Y recorder into a time-base recorder. 613

Computer Control Co. disclosed an exciting miniaturized, transistorized version of its universal 3C-PAC (Series T) gating packages (see March issue of *INSTRUMENTS & AUTOMATION* for a powerful introduction to the symbolic-logic approach to computing and control via gating packages). 614

Military

This show report is headed "Military—Medicine—Miniaturization" because these were the subjects that most impressed your editors. There was great emphasis on air traffic control, with exhibits and papers on VOLSCAN approach control, TACAN data links, CYTAK navigation systems, Optical Glide Path Indicators, etc., etc. But most of these will be discussed in greater detail in our sister publication *MILITARY AUTOMATION;* in *I&A* we wish to call attention to the exciting developments in medical electronics.

Medical

Consider the implications of the work now underway on electronic control of artificial respiration, as revealed in Paper 18.4. Although it has not been possible to pick up usable brain or nerve impulses because of the difficulty of connecting to the proper nerve and the small value of the signal, it is a simple manner to detect impulses in the muscle to which the nerve is directing its signal. Either a surface electrode or a needle can be used to detect the muscle impulse.

As muscles are seldom 100% paralyzed, a usable signal is generated by the muscle—and then electronics takes over to automatically control either the respiration, an automatic arm or leg, etc. In respiration, this is a tremendous advance over the iron lung—an ugly device that permits the individual no freedom of choice in breathing rate, and which makes even drinking a possible drowning hazard. This advance will permit safer surgery on the brain, heart and lungs; it will assist victims of heart attacks; in combination with artificial hearts and lungs already available, it can be a powerful aid to automatic control of many vital body functions that are in need of examination or repair.

Solid-state light amplification also was revealed as having many medical implications (Paper 23.5). For example, a safe X-ray exposure permits only weak pictures, and not much examination. Light amplification can produce good, bright, persistant pictures, even with weak irradiation. Amplifiers with gains of 1000 (lumens out/lumens in) were described in Paper 23.5.

We salute the electronics engineers working with doctors on projects like these—and we wish a few of the military billions (or even road billions) could be earmarked for medical electronics. If our social imagination were even fractionally as advanced as our technical imagination, our society could divert its major emphasis from destruction of people to destruction of germs, perhaps thereby saving civilization in the long run. But we pause here only long enough to emphasize the social significance of medical electronics—and return immediately to the purely technical subject of miniaturization.

A complete new concept, a possible technological breakthrough to a new plateau, was presented by Dr. Cledo Brunetti before Session 25 on "microminiaturization."

Dr. Brunetti pointed out that size of equipment in the past has been described in terms of its components—(1) standard size referring to standard vacuum tubes, (2) miniature size referring to circuits with miniature tubes and components, (3) subminiature size referring to subminiature tubes and components. However, the new concept of micro-miniaturization is based not only on the use of the new solid-state devices (such as transistors) but on the "growing" of an entire electronic circuit—perhaps a multi-stage amplifier—resulting in a pea-sized highly-reliable circuit. This new concept is a fitting conclusion to our show report—and we bring it to you in Dr. Brunetti's own words.

A New Adventure Into Micro-Miniaturization

IN the past, we have spoken of electronic miniaturization when referring to fabrication techniques using the miniature tube as the active element, and subminiaturization for fabrication techniques using the subminiature tube. We may now define microminiaturization as *the design of electronic equipment using solid state and other non-thermionic devices* to obtain another order of magnitude reduction in size and weight.

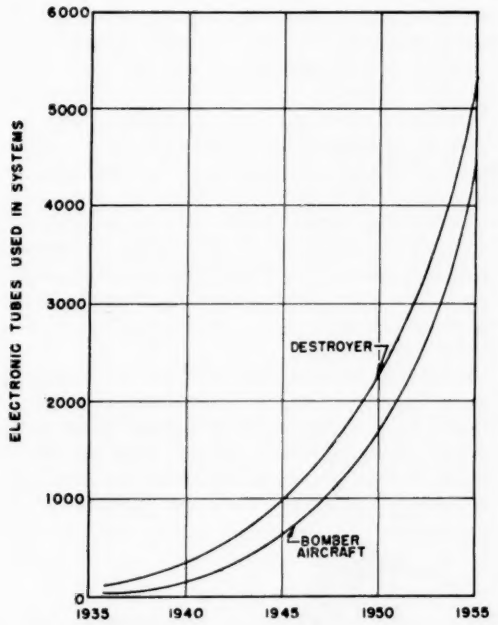


Fig. 1. Number of electronic tubes used in a destroyer or bomber is rising rapidly.

Figure 1 is a graph illustrating the increasing complexity of military electronic weapon systems measured by tubes in use. In 1937, a destroyer used 60 tubes; a 1955 destroyer uses over 5,000 tubes. Similarly, the number of tubes in bomber aircraft has been multiplied by 150 times since 1937. The telephone company tells us that a long-distance carrier system which transmits 1800 separate conversations over one pair of wires once required 600 sq ft of floor space; if it were not for miniaturization, we would be building skyscrapers to house this equipment. Recently, however, the size of this carrier equipment was reduced to that of a kitchen refrigerator.

Abstracts from a keynote address by Dr. Cledo Brunetti, Managing Director, Engineering, Research and Development, Mechanical Div., General Mills, Inc.; paper co-authored by Dr. Otmar Stuetzer, John W. Buffington, and L. K. Lee.

New Materials

Today, the active material of a normal electronic component or circuit accounts for only a small portion of the total volume it takes up. The rest is insulating material and empty space. Even in a tiny transistor the ratio of the volume of the element to the volume of the case is extremely small. The volumetric efficiency of a transistor is less than a thousandth of one per cent. Can we create circuits out of only the active materials first and then pot the entire circuit in one block of insulating material?

As an example of the development and application of new materials, one company has announced an information storage unit which can reduce the size of a memory unit capable of storing a million bits of information to approximately half a cubic foot in volume. This device consists of thin printed plates of a special ferromagnetic material which is molded into small perforated squares 0.83 inch in size. Each square is perforated by 256 apertures, each of which stores a bit, a binary digit.

The transistor is a significant achievement in microminiaturization. This device with an average life of almost 800,000 hours is indicative of the performance of solid-state devices. Its ruggedness is attested by the fact that transistors have survived exposures to shock over 1000 g's. Compare this with the thermionic tube in which the average life is about 5,000 hours and lucky to withstand a few hundred g's. And the transistor is basically a simpler and much smaller structure than a thermionic tube.

Now we have the cryotron, a sliver of wire with another wire coiled around it. It is conceivable by the use of this type component that computers which now occupy dozens of cubic feet can one day be put into one or two cubic feet of space or, might we hope, into a brief case.

Let us not laugh at such seemingly fantastic ideas as this. Indeed, remember the three-dimensional printed circuits we were experimenting with ten years ago. Today we are approaching a state of the art and knowledge of materials where these circuits should be possible and highly efficient.

Solid-State Circuits

In solid-state physics we are only beginning to become acquainted with the possibilities for microminiaturization. We can begin to look forward to what we might call *SOLID STATE CIRCUITS*. I would like to define such circuits as three-dimensional combinations of metallic, inter-metallic and insulating materials which transmit and control currents in the same manner as combinations of ordinary electronic components. Through continued research in the improvement of the types of materials used and the

techniques for depositing them, we should be able to effect at least an order of magnitude size reduction and a corresponding increase in reliability.

A solid-state circuit, now containing active devices, might look like that shown in Figure 2. Schematically shown is a conventional combination of a preamplifier stage and cathode coupled amplifier stage. Also shown is its solid-state-circuit equivalent, consisting

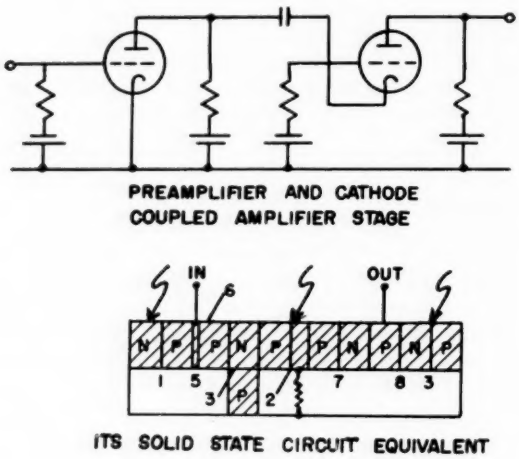


Fig. 2. It may be possible to grow the entire solid-state circuit equivalent of a multi-stage amplifier.

entirely of a sequence of P-N junctions such as can now be produced by rate of growing techniques.

The junctions 1, 2 and 3 are used as power supply batteries by shining a suitable amount of light on them; 1, 3, and 4 are resistors, being junctions biased in the direction of high resistivity; 5 and 2 are emitter junctions for the two transistor combinations in the circuit; 6, 7 and 8 have no particular function; they are needed only to obtain the right transitions on the places needed and are made ohmic contacts by surface treatment. By using this system of power supply, the number of connections is minimized and blocking condensors are eliminated, and minimum dimensions are prescribed by the diffusion lengths of the carriers in the respective junctions. The absence of connectors and terminals is an obvious advantage of this type of construction.

Carrying one's imagination a step further, we can visualize combinations of germanium, silicon, ferroelectric, ferromagnetic and other types of organic materials deposited automatically in volumes of a thousandth the space now occupied by electronics produced by ordinary methods.

To achieve satisfactory circuits by these means, we will have to engage in a great deal of research and development work delving into the physics and chemistry of conducting, semi-conducting, insulating, dielectric, magnetic, ferroelectric and many other types of materials.

New Physical Phenomena

While we can look for substantial reduction in size and weight of present types of electronic components through the use of better and more efficient materials and improved packaging techniques, our real breakthrough in micro-miniaturization will probably come from some totally new approach and the continued exploitation of the newer concepts of electronic materials.

Let us rethink our circuits through in terms of what each component or group of components is supposed to do to the current or voltage. See if we can't find a simpler way. Can we go from the input to the desired output directly? R, L, and C are mathematical concepts and may disappear as we go to the ultimate. We can treat a circuit as a short transmission line with distributed constants. Can we also use interrelated force fields (electro-static, magnetic, and others) to control the flow of current?

Walter Hausz has another interesting idea. "Fundamental to the many ways of making electronic equipment smaller is the realization that many of the things we want to do are at the information handling rather than the power handling level. Power levels of components can be in micro-micro watts before they approach inherent noise levels that jeopardize their operation." Indeed, some sensory devices, such as the eye, already approach the ultimate and require very few quanta of input to produce a detectable signal output.

When we compare electronic computers with the human brain, we see how much work is needed just to catch up with Mother Nature. Some of her designs are not vastly different from our own, but the difference in size is astounding. Compare the micro-miniaturized human eye and nerve system to its elec-

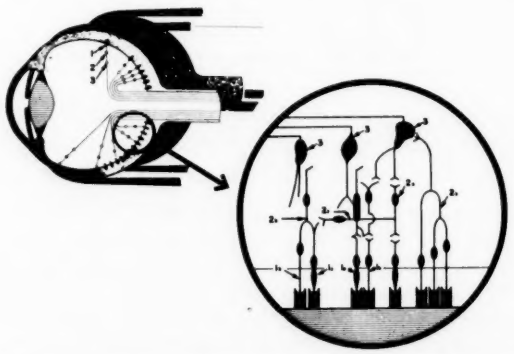


Fig. 3. The human eye is a micro-miniaturized transducing, generating, modulating, and control system.

tronic counterpart. Nature has contained in just several cubic inches the optical transducer and generating, modulating and control system to convert a visual picture into a parallel series of constant-amplitude pulse-modulated signals to the brain. A simplified drawing of this system is shown schematically in Figure 3. An electronic system, using sub-miniature techniques, would require something of the order of 120 cubic feet of space, or approximately 60,000 *times larger than the human optical system.*

Would we not be wise to look more closely at the performance of organic materials in our efforts to micro-miniaturize? First, we should bring together the electron scientists and the organic or physiological scientists in an effort to bring them on common ground with common objectives. Then perhaps an effort should be made to create workable organic components and systems as well as to understand those produced in nature. Both organic components and systems should be analyzed. Nature has a marvelous system of connectors. Perhaps these should be studied even more than the organic components.

In the human brain, not only can a wealth of information be stored in a very small space, but we have access to much of this information at a moment's notice. The random access problem has been solved and all the storage mechanisms needed are contained in a volume of several cubic inches, and during our most concentrated thinking, we are dissipating less than a tenth of a watt of power.

Great gains can also be accomplished if we can find better ways of transferring heat away from components. Instead of protecting a resistor by embedding it in plastic material, could we surround it first by a thin coat of insulating material such as beryllium oxide, and then a peltier junction? Recalling the peltier effect, what other new ideas can we come up with in solid-state thermal converters to dissipate heat by converting it into another form of energy? Imagine several transistors cooling themselves on a peltier junction (Figure 4).

Our goal is to be able to build electronic equipment of a size belonging more to the insect world than to our own, and of 100 per cent reliability under all conditions of pressure, temperature, shock, and vibration.

Mother Nature did a marvelously expert job of creating the human brain. Its capacity is astounding, and its size a true achievement of micro-miniaturization. But the human brain exists in delicate balance with its environment, and it is temperamental. Temperature and atmospheric changes can snuff out its life, and its efficiency is greatly affected by the lack of rest and food. Through electronic micro-miniaturization we hope to be able to build a brain —a computer—which will be able to do much the same as the human brain but which will be impervious to damage from temperature, shock, vibration or any other antagonistic condition and which will still achieve the optimum in space efficiency. Reliability must not be compromised. The achievement of this goal is a long and difficult task. We have taken some first steps, but many new and novel concepts will have to be created.

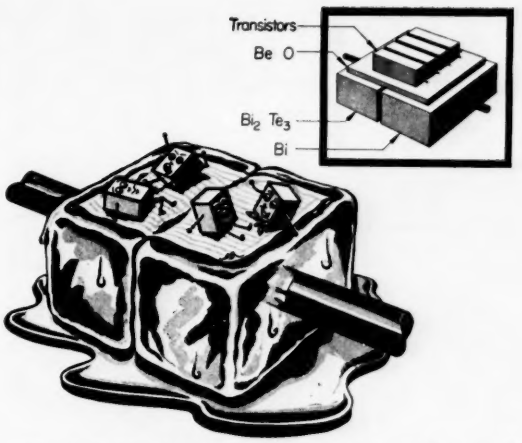


Fig. 4. Peltier junction can be used to cool a small volume.

Dear D. R.*:

We want to apologize for missing our personal letter to you last month, and want to take this opportunity to point out some matters of importance about both the last issue (March) and this April issue.

Not every issue can contain articles that have new concepts; that open entire new fields of thought and areas of work. So if you happened to miss (or skim over) the article "Logical Design with Symbolic Logic" by Bob Brooks in the March issue, go back and read it carefully. It is beautifully clear and simple, and a lot of future material which you will receive in *I&A* will presuppose your familiarity with this new concept—symbolic logic. And while you have that March issue, earmark the article "Cost of Pneumatic Control Systems" by Tommy Thomas. This is the result of years of work by Tommy, and Carbide & Carbon Chemicals Company deserves the applause of our entire field for making this invaluable data public.

In this issue, you will learn how simple it is to program a digital computer, in this case the ALWAC. (Next month you program the E-101, so you can compare the operations.) You'll like this article because it takes an operation that many consider to be very difficult and shows how really simple it is.

We think you will get a kick out of George & Paul Amber's "Yardstick for Automation," on page 677. Also, the article "P-E-P" (pages 678-79) is important because it shows a simple and reliable way to use electric transmission with your familiar and reliable pneumatic instrumentation.

The article "Trends in Pipeline Valve Control," beginning on page 708, tells us that some exciting things are happening in the field of large plug- and gate-valve control.

Our editorial this month covers the IRE Show for you. It includes some interesting new concepts suggested by Dr. Cledo Brunetti. Hope you like it.

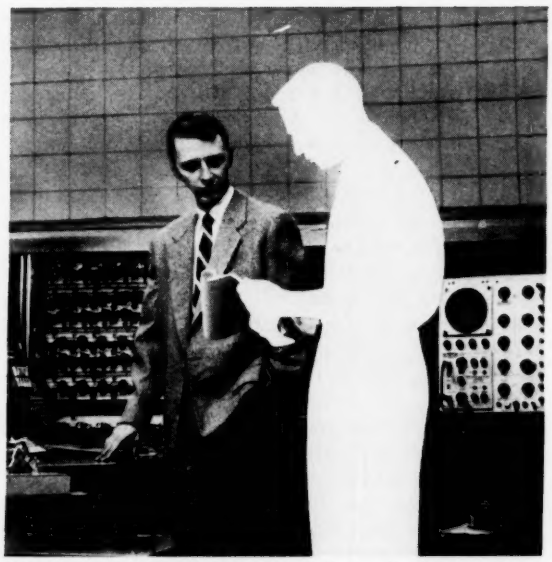
And we hope also that this issue finds you (reading) well and happy this month.

Cordially
Milt and the Editors

*Dear Reader

IBM GROWTH promoted these men

PRODUCT DEVELOPMENT ENGINEER: Before his recent promotion, this man was a member of a small engineering "team" (two M.E.'s, an E.E. and a model maker) in IBM's Poughkeepsie plant. His specific project entailed the creation of the "ultimate package in printed circuitry." His group "brainstormed" the project in continual sessions, putting the results in model form. Then the group would try to "tear the idea to shreds" in order to create something even better.



PRODUCT CONTROL ENGINEER: Promoted recently, this man formerly worked at IBM's Poughkeepsie manufacturing facilities. His job was to design information systems to insure a smooth flow of work through the plant. "It takes *creative* engineering ability to design these systems," he'll tell you, "and *administrative* ability to 'sell' a system to higher management and make it stick. If you possess this rare combination of abilities, this is the job for you!"

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- Computer systems testing
- Test equipment design

Economic experts rank the electronic computer with automation and nucleonics in growth potential. More than 10,000 electronic computers will be in operation by 1966. IBM sales have doubled, on the average, every five years since 1930. IBM engineering laboratory personnel quintupled in the past five years. IBM spent $19,000,000 on research and new product development in 1956. Salaries are excellent; company-paid benefits set standards for industry today. Personnel turnover at IBM is less than one-sixth the national average.

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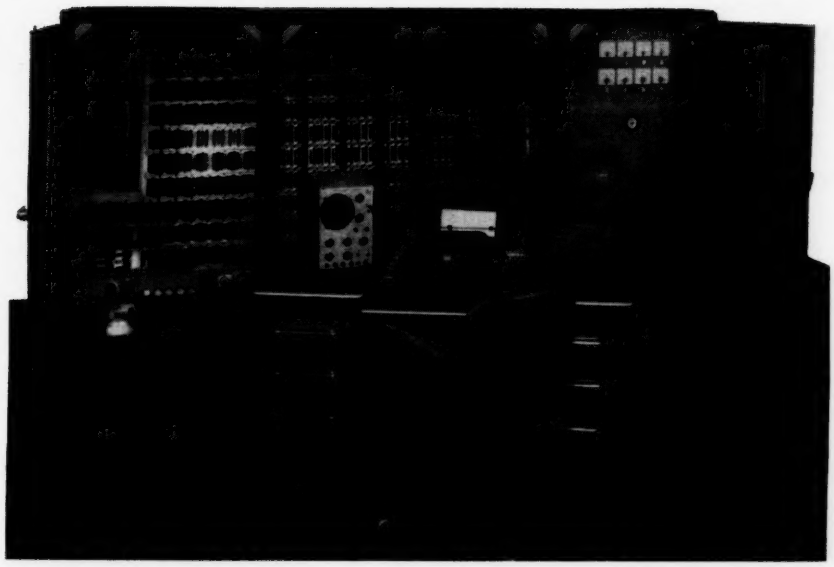


Fig. 18-1. The ALWAC III-E digital computer.

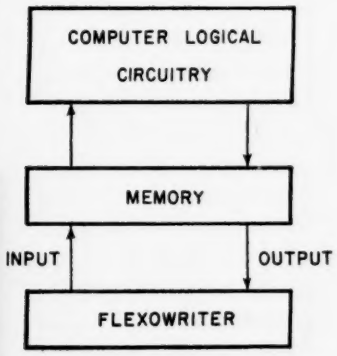


Fig. 18-2. Block diagram of ALWAC is similar to that of most digital computers.

Programming a Computer

DIGITAL AUTOMATION—NO. 18

The art of programming a computer is the simple one of learning the technique for telling the computer where to go to get the data, what to do with the data, and where to place the result. The machine makes no decisions except those programmed.

MARTIN L. KLEIN
FRANK K. WILLIAMS
HARRY C. MORGAN
Rocketdyne Div.,
North American Aviation, Inc.

PROGRAMMING a computer is like dispatching a messenger boy. One tells him where to go, what to get, and what to do with it. In a digital computer, one tells the machine where to get the data, what to do with it, and where to place the result. In other words, a computing-machine program is essentially a detailed routing procedure which guides the machine for every and any contingency. Contrary to common belief, the machine is unable to make decisions for itself and always relies on the programmer for what steps to take.

We are going to go through some of the basic steps in programming a digital computer; the discussion will revolve around a real computer, the ALWAC III-E. This machine (Fig. 18-1) is used as an example because it in a versatile low-priced digital computer.

Hexadecimal Language

The fundamental language for instructions given to ALWAC is a hexadecimal number system. This is a 16-symbol code (Table 18-1), and as there are only 10 arabic numerals it is customary to designate numbers 11 through 15 as letters. Note that 4 binary bits represent one hexadecimal column—that is, any one hexadecimal digit can be represented by four bits.

The basic organization of ALWAC (Fig. 18-2) is the same as that of most digital computers. Data and instructions are stored on a magnetic drum.

Arithmetic operations, such as addition, subtraction and multiplication, are performed in 3 *registers* known as the A, B, and D registers, each of which holds one word.

Table 18-1—Hexadecimal Code

Decimal	Hexadecimal	Binary
0	0	0
1	1	1
2	2	10
3	3	11
4	4	100
5	5	101
6	6	110
7	7	111
8	8	1000
9	9	1001
10	a	1010
11	b	1011
12	c	1100
13	d	1101
14	e	1110
15	f	1111
16	10	10000

Table 18-2—Instruction Codes, ALWAC III-E, By Groups

ARITHMETIC

61	Add
67	Subtract
63	Minus add
65	Minus subtract
bd	Long add
bf	Long subtract
e7	Multiply
e5	Multiply by D
e3	Add multiply
e1	Add multiply by D
ef	Divide
ed	Divide by D
eb	Long divide
e9	Long divide by D

ACCUMULATOR

22	Round off
28	Clear A
2c	Absolute value
2e	Reverse A sign
3e	Complement A

SHIFT

a1	Double shift right
a3	Double shift left
a5	Shift right
a7	Shift left
ab	Float

INPUT-OUTPUT

f1	Hex. in
f3	Alphabet in
f5	Hex. out
f7	Alphabet out
f9	Sign in
d5	Sign out
dd	Number out
9b	Type
9d	Punch
9f	Both
99	Neither

COPY & EXCHANGE

69	Exchange A and W
49	Copy A to W
79	Copy W to A
b5	Copy M to A
30	Exchange A and B
c5	Copy B to W
41	Copy W to B
32	Copy B to A
3a	Exchange A and D
c7	Copy D to W
5b	Copy W to D
38	Copy D to A
36	Exchange A and E
c3	Copy E to W
57	Copy W to E
34	Copy E to A
4d	Copy address to W
4f	Copy half to W
6d	Copy Address to A
6f	Copy half to A
71	Extract (D)
75	Extract

BLOCK COPY

81	Copy to I
83	Copy to II
85	Copy to III
87	Copy to IV
89	Copy from I
8b	Copy from II
8d	Copy from III
8f	Copy from IV

JUMP & RELATED

11	Jump
13	Control jump 1
15	Control jump 2
17	Count down
19	Non-zero jump
1b	Stop
1d	Less than zero jump
1f	Overflow jump
51	Overflow if A smaller
02	Reverse overflow

Two instructions can be doubled up if the first is an even-numbered instruction; but it must be made odd by adding 1. The second can be any instruction not requiring an address. Odd numbered instructions will have their addresses automatically modified if the instruction is made even by subtracting 1.

A word consists of 32 binary bits—equivalent to 8 hexadecimal characters plus sign. A typical word might be as shown in Fig. 18-3.

Note in Fig. 18-3 that one part of the word is devoted to an instruction and the other part of the word is devoted to the address; note also that each word of 32 binary digits represents two successive operations.

It is customary to organize all of the programming on a *data sheet* (Fig. 18-4). Note that each word has room for the data shown in Fig. 18-3. Note also that each word is numbered in hexadecimal notation.

Fig. 18-5 shows the instruction progression. Instructions 1 and 2 are written on the top "word." Instructions 3 and 4 are written on the second word, etc.

Instructions

Ordinarily, one designates instructions and the location from which the data to be operated on are obtained. Thus, one may say to the machine:

1. Find the number on the drum in position 01.
2. Place it in the "A" register.
3. Find the number on the magnetic drum in position 03.
4. Add it to the number which is now in the "A" register.
5. Take the result and put it back on the magnetic drum in position 05.

In programming the machine, one must think through each and every step in this manner and then, using the data sheet shown in Fig. 18-4, record these instructions in the hexadecimal code used by the computer. The following few instructions will serve as illustration:

61	Add
67	Subtract
e7	Multiply

A complete list of instruction codes, by group, is given in Table 18-2.

In addition, the following symbols and facts are of importance:

1. A register accumulator holds sums, differences, and remainders.
2. B register holds multiplicands, dividends, and quotients.
3. D register holds multipliers and divisers.
4. W—a word location of the total of 128 available in the working storage.
5. M—a word location on the main memory.

Adding Two Numbers

Let us add two numbers previously stored in the working memory in, say, positions 01 and 03. To build up this example on the data sheet, we proceed as follows:

The first step is to enter the number already in memory location 01 into the accumulator, after finding it (this automatically clears the accumulator of what was in it). This step is instruction number one and, therefore, our data sheet now looks like Fig. 18-6.

Now we must add to this the number in storage location 03. Entering this on the coding sheet, we now have Fig. 18-7. The sum is now standing in the "A" register and all that remains is to transfer it back to memory

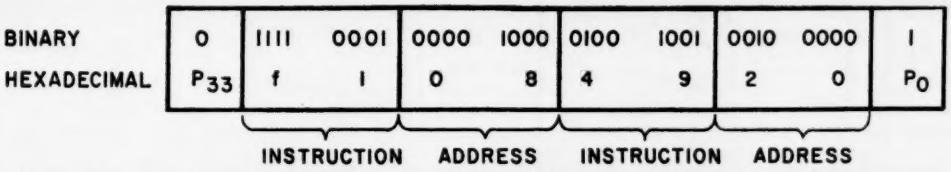
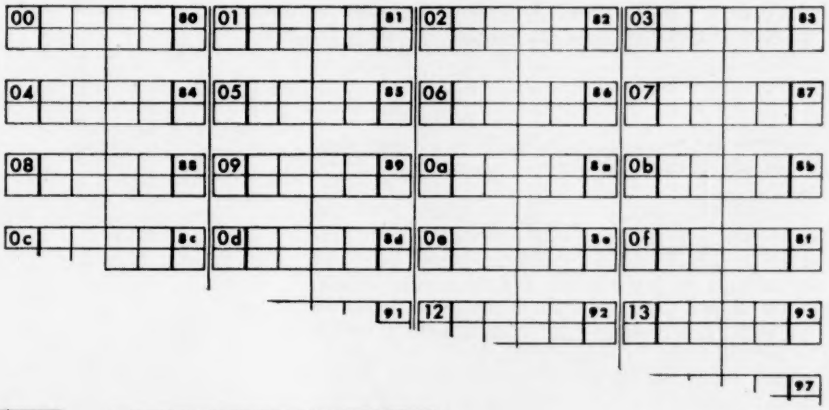


Fig. 18-3. One instruction word has 8 hexadecimal digits (or 32 binary bits) plus sign. Note that this one word comprises two instructions and two addresses, and that each word of 32 binary digits represents two successive operations.

Fig. 18-4. Part of one data sheet.



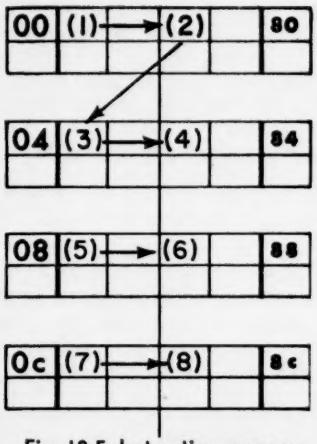


Fig. 18-5. Instruction progression for the first eight instructions.

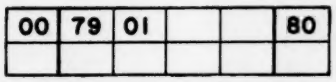


Fig. 18-6. First step in adding two numbers is to enter one of the numbers (the one already in memory location 01) into the accumulator. This is done by instruction "79."

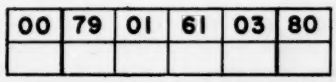


Fig. 18-7. Second instruction (61) adds number in memory location 03 to the number in the accumulator. Result remains in the accumulator.

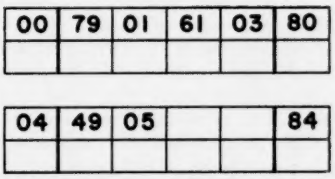


Fig. 18-8. Third instruction (49) transfers the sum standing in the accumulator (A register) into location 05.

location 05. This instruction results in a coding sheet as shown in Fig. 18-8. This simple program is now complete. As matters stand, we have the original numbers which were added still in the memory locations 01 and 03, and the sum in memory location 05 and in the "A" register.

These three steps would be evaluated in three milliseconds on ALWAC III-E.

The reason for such detailed listings on the data sheet is that one must be fully aware of everything that is going on, and the status of all of the registers. One must not forget that a memory location has a number stored in it and then dump in another number in on top of it, because the previous number will be lost.

Adding a Series of Numbers

As a further illustration of programming, a program of slightly greater complexity will be given. Let us suppose that nine numbers are stored in consecutive memory cells from 10-18. A number called n (which is smaller than nine) is stored in cell, say, 1a. The following is a routine which will store in cell 1b the sum of the first n of the nine numbers which are stored in memory locations 10-18. If n is 4, for example, we will add the first four of these nine numbers and obtain the resultant sum in memory cell 1b. In this instance, the number n is four. Note that we do not know what the numbers are in memory cells 10-18 because they have been placed there from some previous part of the program.

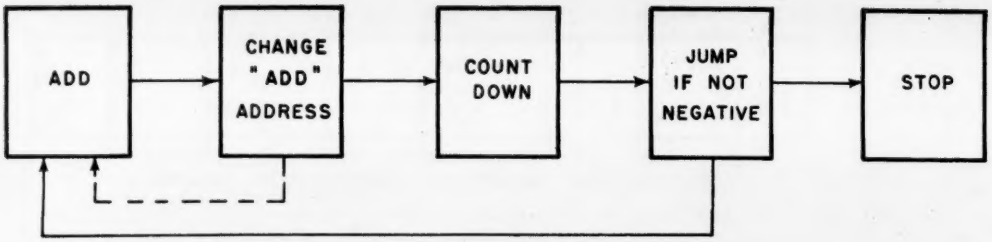


Fig. 18-9. Block diagram, or course of logic, for adding a given number of numbers in a series of numbers. Program is called a branch type or escape type because output of certain blocks can branch into various paths.

the numbers are in memory cells 10-18 because they have been placed there from some previous part of the program.

Ordinarily, in programs of this complexity, it is customary to first plan the steps with a *block diagram*. This serves as a course of action which checks the logic and yet does not get the programmer into the specific details. The block diagram for the problem suggested is shown in Fig. 18-9. This general type of program, in which one of the blocks has a single input and a multiplicity of outputs (such as the block labeled "Jump if not Negative"), is known as the *branch logical program*. That is, steps are introduced so that the program can tell whether it has completed itself or should go back around the loop. This branch block is sometimes known as an *escape*.

It might be pointed out that this program is not the most obvious way of adding the nine numbers stored in cells 10-18. One could, in principle, simply write a program with a series of nine additions and arrive at the same result. However, a program written with branch logic considerably reduces the number of steps in the program and puts the burden of repeating the addition steps only as many times as required on the machine. Therefore, the logical block "Jump if not Negative" in the block diagram of Fig. 18-9 is essentially a point at which the computer decides how many additions it has made. If it has made n additions, the program stops; if it has not made n additions, it goes back around the loop again and continues adding until the number of additions desired by the programmer is made.

As a secondary step, the block diagram is converted into a flow chart as shown in Fig. 18-10. The flow chart shows the specific instructions to carry out the steps desired, with brief notation which refers it back to the block diagram to insure that everything is being done. Referring to the flow chart, one sees the first three instructions as 79, 6110, and 49. These three instructions together represent the add block in the block diagram (79 is an instruction which brings a word in the memory into the add or A register; 6110 is the instruction which adds storage location 10—whatever this number may be —to the number in the A register; 49 takes this sum and places it back into the memory location specified). As the sum is to be stored in cell 1b, the complete program for the add step reads 79 1b, 6110, and 49 1b. This is shown at the left in Fig. 18-11, the data sheet.

Referring once more to Fig. 18-10, the *change "add" address* block is represented by the second three instructions 79, 61 1, and 49. These instructions mean (1) take a number from memory, (2) add one to it, and then

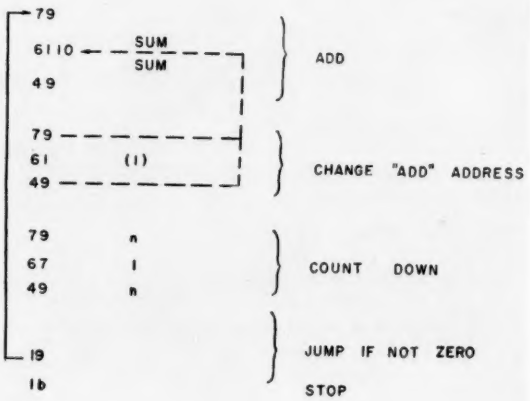


Fig. 18-10. Flow chart for block diagram of Fig. 18-9.

(3) put it back in a memory location. This is an address modification which essentially replaces the 10 in 61 10 by the next highest number so that when the program repeats, it will take the number stored in the next memory location, having already added the number from the previous addition. In other words, in the first time around, we have picked up the number in memory location 10 on the command 6110. This second block has now changed this command to 6111, so that on the second time around the number added will come from memory location 11. On the third time around, this address will be modified to pick up the number 6112, etc.

The numbers 79, 67, and 49 are the "count down block." This is essentially a tally of the number of additions made. As we wish the machine to add only the first four storage locations, we use the number 4 for the letter n. The 79 instruction brings this particular number from the memory location, and the instruction 67 subtracts one from this number. The instruction 49 puts the difference back in memory for use the next time around.

Note that when we have gone around the loop n times the number that is put back in memory is zero ($4 - 4 = 0$). This indicates that the desired number of additions has been completed.

The criterian for whether the program is complete or not, is whether this number is zero. We take advantage of this at the branch point with the instructions 19 and

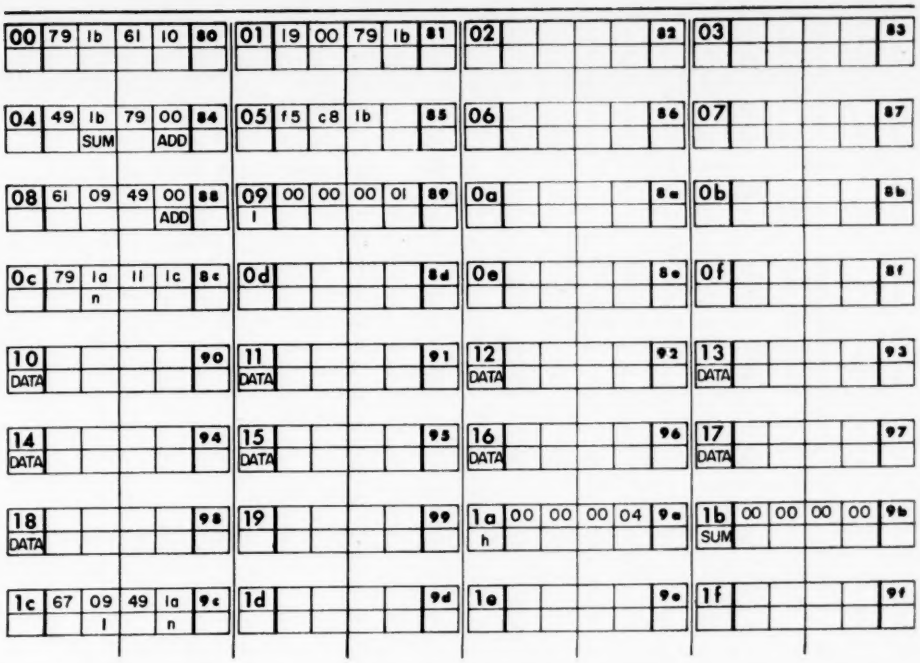


Fig. 18-11. Complete data sheet for serial addition problem.

1b; 19 tests to see if the number in A is zero; if it is, it ignores the address and proceeds to the next cell for its next instruction. This instruction (1b) is a stop for the machine. If the number is not zero, the program transfers to the address specified in the 19 command, which is the beginning of the loop. Finally, we need two commands to call the sum to the "A" register and print it out. After that, the machine stops; thus, cell 81 contains a 79 instruction, while cell 05 contains the instruction f5c8 (f5 tells the machine to *output* numbers, the c tells it to convert from hexadecimal machine language to decimal, and the 8 indicates the number of digits to be printed out by this command).

We have concluded the list of instructions, or steps, to execute the program. All that remains is to specify the particular memory locations and to place these instructions in a systematic order so that they can be punched on, say, paper tape. This tape then can be fed into the input of the computer and all of these instructions can be stored internally for the execution of the program anytime the machine is instructed to go through this program. The complete data sheet for this particular program is shown in Fig. 18-11.

Payroll Computation

One typical application for computing machines is payroll computation. Payroll is probably, at present, the most common use for automatic calculating equipment, particularly where the same payroll deductions and computations are required for several thousand persons every week.

One part of the payroll computation is the calculation of the FICA tax each week at a rate of 2% on the first

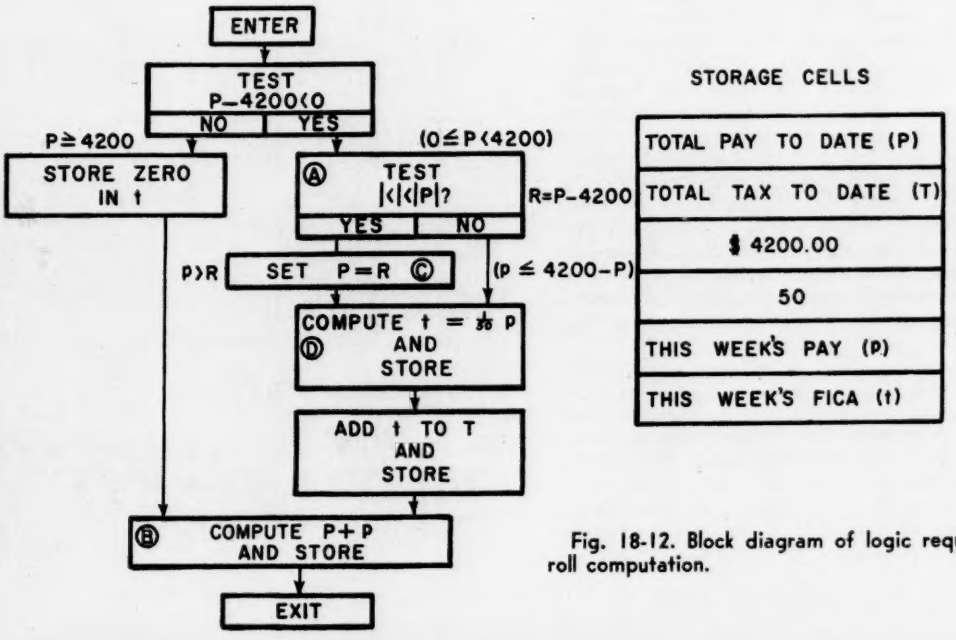


Fig. 18-12. Block diagram of logic required for payroll computation.

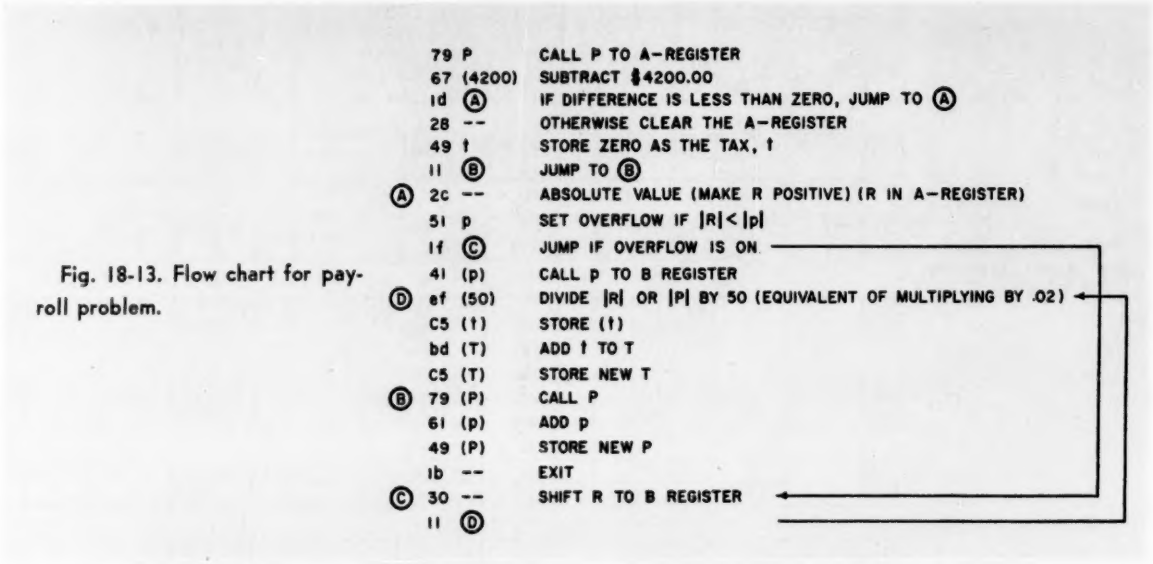

79 P CALL P TO A-REGISTER
67 (4200) SUBTRACT $4200.00
1d Ⓐ IF DIFFERENCE IS LESS THAN ZERO, JUMP TO Ⓐ
28 -- OTHERWISE CLEAR THE A-REGISTER
49 t STORE ZERO AS THE TAX, t
11 Ⓑ JUMP TO Ⓑ
Ⓐ 2c -- ABSOLUTE VALUE (MAKE R POSITIVE) (R IN A-REGISTER)
51 p SET OVERFLOW IF |R|<|p|
1f Ⓒ JUMP IF OVERFLOW IS ON
41 (p) CALL p TO B REGISTER
Ⓓ ef (50) DIVIDE |R| OR |P| BY 50 (EQUIVALENT OF MULTIPLYING BY .02)
C5 (t) STORE (t)
bd (T) ADD t TO T
C5 (T) STORE NEW T
Ⓑ 79 (P) CALL P
61 (p) ADD p
49 (P) STORE NEW P
1b -- EXIT
Ⓒ 30 -- SHIFT R TO B REGISTER
11 Ⓓ

Fig. 18-13. Flow chart for payroll problem.

$4200.00 of the years total pay. Thus, two tests must be made—one to determine if the employee has reached $4200.00 in total earnings this year, and if not, then to determine whether this week's earnings will cause his total to exceed $4200.00. In this latter case, only that part of this week's pay which brings his total to $4200.00, and not the surplus, is taxable.

The storage cells are presumed to hold data as indicated, some inserted by a previous portion of the program, some generated in this program, and some stored for access to a further part of the program not shown. The decimal points are added at time of output since all amounts are uniformly carried in sets.

The first step, here again, is to set down the mathematical operations of the logic to perform the two tests required. This is done in the block diagram in Fig. 18-12. Note that there are several branches in the logic. The principal branch is a decision as to whether the total earnings P, exceed or do not exceed $4200.00. In the event they do, the weekly FICA (t) is 0 because there would be no deduction and we simply add this week's pay (p) to the pay to date (P), and store the result for next week. This is the "no" branch in the logic. If the total pay is less than $4200.00, we go down the "yes" branch.

The second test is to determine the residual (R) which is taxable. That is, what part of the weekly pay is to be taxed? If the total weekly pay is taxable, we go down the sub-branch "yes"; if only a part of the weekly pay is taxable, we go down the "no" branch. Whichever amount is chosen, 2% (1/50th) is calculated in block D. This is the essentially simple computation necessary for making a payroll. The flow chart is shown in Fig. 18-12.

The machine coding sheet is shown in Fig. 18-13. The first instruction calls the employee's total pay from memory into the A register. We next subtract the fixed quantity $4200.00 stored in 2b, and then make a branch in the logic with a less-than-zero jump. This latter instruction is in cell a4.

To continue down the "no" branch, we clear the A register (28) and then store 0 as the tax. Instruction 2c tells us to jump to location bc, which has the instruction 79, 23. This latter instruction copies the total pay from memory location 23 into the accumulator. The following instruction (21) tells the machine to add the employee's weekly pay (p); then instruction a1 stores the initial total earning payment in the original memory location 23. Instruction 25 terminates the program and stops the machine.

The "yes" branch for the logic which covers the situations where the total pay is still taxable is not shown in its entirety—but requires only six more steps.

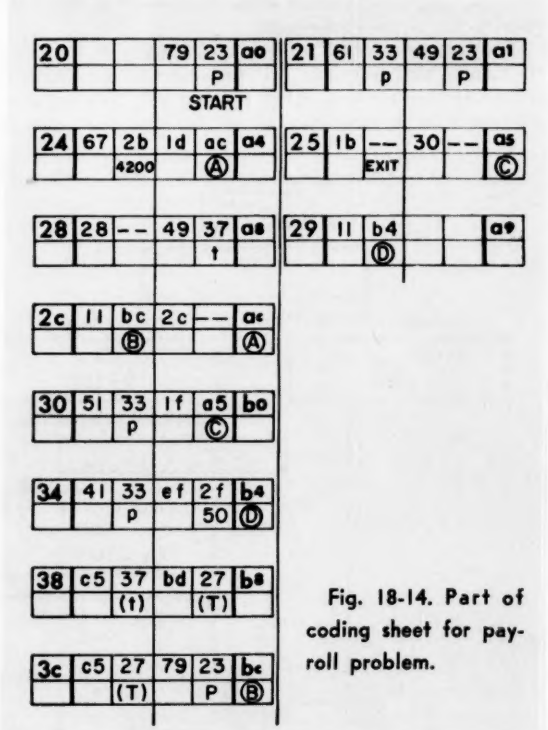


Fig. 18-14. Part of coding sheet for payroll problem.

A Yardstick for Automation

Various techniques have been used to classify automation devices into basic sub-units. James Bright used the graphic "Automation Profile," Leaver and Brown wrote a "Functional Morphology of Mechanisms," and Amber and Amber here propose a mathematical notation based on the information and energy.

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and
PAUL S. AMBER
Machine Control Consultants

Order of Automaticity	Symbol	Human faculty accomplished by machine	Characteristics of this order of automaticity	Examples of devices and machines having this order of automaticity
Zero Order	A_0	None. Replaces no human energy or control function.	Includes all hand tools. They increase worker's efficiency, but replace no human function.	Shovel, knife, hammer, pliers.
			Includes all hand energized machines. They give mechanical advantages, but replace no human function.	Block & tackle, pencil sharpener, bow & arrow, pump, can opener.
First Order	A_1	Energy required to do basic machine function.	Uses mechanical power source, but machine feed and control completely dependent upon operator.	Cement troweling machine; bench saws; pneumatic drill; portable electric tools; floor polisher; wood lathe.
Second Order	A_2	All energy required to do basic machine function. Also automatic feed.	Uses 100% mechanical power, but operator must do complete set-up, and on-off and control.	Radial drill, bench lathe, power hack saw, pipe threading machine.
Third Order	A_3	Controlling the machine.	Completely self acting—the first true "automatics". "Open loop" performance.	Turret lathe; transfer machine; grinding machines; gear hobbers; screw machines; special manufacturing machines, such as for cigarettes, lamp bulbs, and bottling.
Fourth Order	A_4	Monitoring machine performance.	Measures machine performance, compares to a standard, corrects machine as necessary. "Closed loop" feed back control performance.	Ruling engine, honing machines, cold reduction mill, chemical process plants, oil refineries, generators, speed regulators, level controls.
Fifth Order	A_5	Performing calculations.	Machine control is based on automatic solution of control equations.	Machines that use small special purpose computers such as machine-mean computer; standard deviation computer.
Sixth Order	A_6	Obeying complex logic, performs "deductive reasoning".	Machine control is based on automatic solution of complex formal logic conditions (A_5 and A_6 overlap somewhat)	Telephone circuits, bowling pin spotter, elevator controls, cypac machine controls, "Robots."
Seventh Order	A_7	Learning by experience.	Machine learns from its mistakes, and attempts different modes of operation as necessary, and improves its techniques.	A paper talk machine so far, which is theoretically possible, but has not yet been attempted
Eighth Order	A_8	Performs inductive reasoning. Has intuition and executive type judgment.	Machine extrapolates from its experience, and forms modes of operation beyond actual experience, resembling intuitive operation and judgment.	This could be an automatic Operations Research machine that sets up much of its own local programming.
Ninth Order	A_9	Creativeness—originality.	Machine comes up with original, creative concepts, and can work beyond its programming.	As there is no agreement what constitutes creativeness for men, there will be no agreement on creative machines. Do we want a machine of this type?
Tenth Order	A_{10}	Dominance	Machines give the orders to the operators and designers.	Science fiction writers take over from here. A dictatorship by machines!

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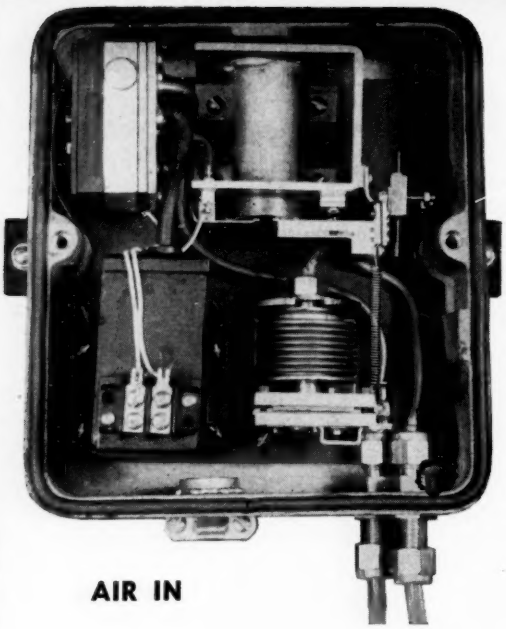
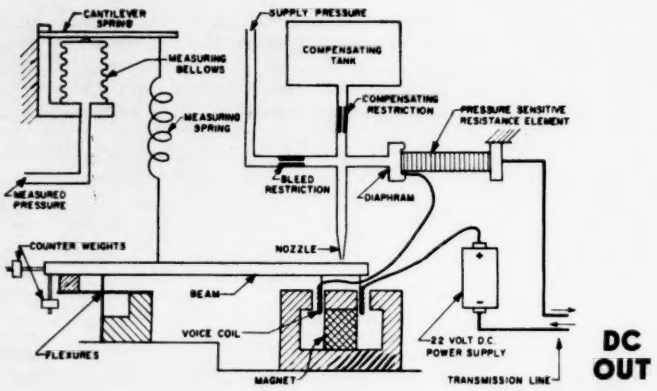


Fig. 1. Transmitter accepts pneumatic input and uses pressure-sensitive resistance element to produce a d-c output.



P-E-P: Pneumatic — Electric — Pneumatic

DURING the past two or three years there have been many papers written and many panel discussions held on the relative merits and demerits of electronic and pneumatic control systems.

Just as hybrids have been shown to have marked superiority over pure bred strains in fields such as agriculture, perhaps a hybrid system may be the real answer to this electronic-pneumatic dispute.

Electric *transmission* for measuring, controlling and recording systems in industrial plants has been preferred in many cases for the following reasons:

1. Electric transmission lines are relatively inexpensive to install.

2. Electric transmission lines are relatively trouble-free and inexpensive to maintain.

3. Velocity of propagation of a signal down the lines is extremely high. However, it is our opinion that the advantages of electric transmission systems, compared to pneumatic systems, have been somewhat neutralized by the complexity of the equipment necessary for converting measured variables or pneumatic control signals to electric signals.

Ideally, the equipment used in conjunction with electric transmission systems should have the following characteristics:

1. No vacuum tubes, transistors or troublesome components should be used.

2. The critical electrical energy level necessary to cause an explosion should be at least 500% above that actually available.

3. Transmission signals should be direct current (we have chosen 3-15 milliamperes) so as to be insensitive to 60-cps pickup, and also because a d-c signal is easier to use in high-speed scanning systems.

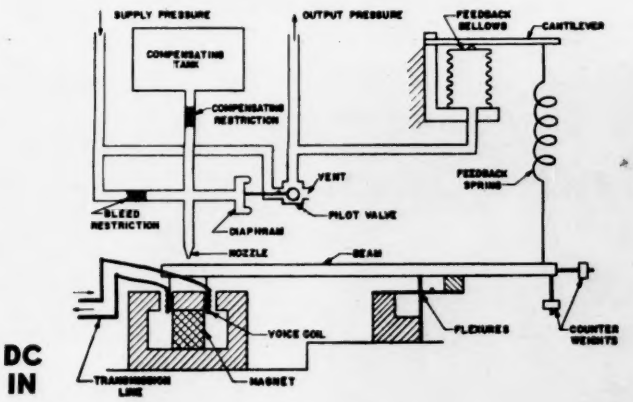
The d-c transmission system to be described, comprising a transmitter and a receiver, satisfies the requirements outlined.

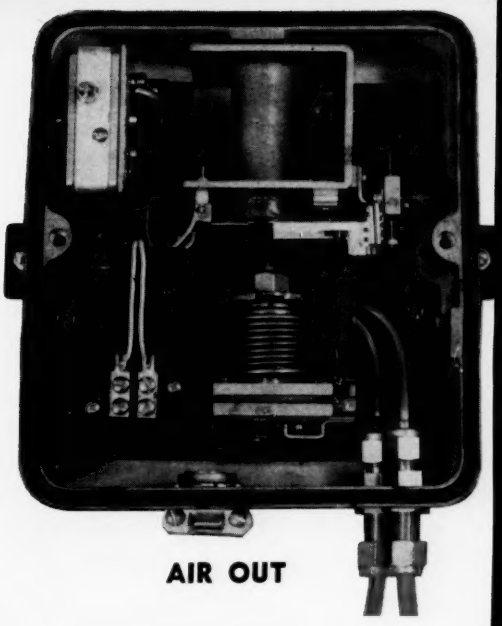
The Transmitter

A pressure to direct-current transducer is shown in Fig. 1, with the output current transmitted to a current-to-air-pressure converter shown in Fig. 2. In the transmitter, force applied to the flexure pivoted beam, via the measuring spring, affects the pneumatic flapper-nozzle separation. This results in a change of the nozzle back pressure which, when applied to a diaphragm connected to a force-sensitive element, causes a corresponding change in its resistance. (Conventional carbon piles and pressure-sensitive powders may be used for this component.) This change of resistance produces the change in line current necessary to balance the beam via the voice coil (pot coil). Thus, a direct-current output is obtained that is directly proportional to the measured variable applying the input force to the beam.

This transducer utilizes the large power gain available from a flapper-nozzle pneumatic amplifier instead of making use of electronic circuits. The input signal is force (from any measuring element); the output is direct current.

Fig. 2. Receiver converts d-c input into an equivalent pneumatic output.





Transmission

RALPH V. COLES, DUDLEY D. NYE, and ROGER F. WERNLUND

Fielden Instrument Div.
Robertshaw-Fulton Controls Co.

The Receiver

The basic current receiver, or current-to-pneumatic-pressure converter, shown in Fig. 2 is similar to other equivalent devices on the market. A change in the received current in the voice coil changes the flapper-nozzle separation, and a corresponding change in nozzle back-pressure is used to balance the beam via the feedback bellows and spring, as well as for actuating a control valve or other pneumatic equipment.

The authors feel that the use of a high-capacity pilot valve in such a device is very important when attempting to supply air to pneumatic devices having large input volumes. Otherwise the advantages of instantaneous transmission of signals is nullified due to the time constant of the pneumatic output system.

It is clear that the input motion may be from various elements such as bourdon tubes, bellows, filled systems or mechanical pickups of various types, so that the system can be applied to direct process variable transmission and to valve positioners as well as control signal transmission.

Under development also is an electric-pneumatic controller which receives a current representative of the measured variable from the transmitter, and has an output current to be transmitted to the current receiver for actuating the control valve or other devices. The controller utilizes the same construction as the transmitter but has an appropriate feedback network so as to produce proportional, reset, and rate actions. The air supplied to the system is used only as a power amplifier and does not appear as an input or output signal. It is clear also that the feedback bellows in the receiver can be used to position the pen of a recorder.

Thus a complete measuring, recording, transmitting and controlling system with electric transmission has been evolved without the use of vacuum tubes or electronic components. The authors feel that the standard current variation of 3-15 milliamperes is a wise choice because 3-15 psi is the standard range for pneumatic equipment. Thus in cases where the system is used in conjunction with other pneumatic systems no conversion factors are necessary when observing and comparing currents and air pressures.

A family of transducers (primary elements) are being designed around the system for test and evaluation.

While the d-c system, as compared to a 60-cycle a-c system, is probably somewhat less susceptible to extraneous interference and pick up, we do not regard this as a major factor in an individual-channel system. In both cases the output signals of all primary-element transducers can be standardized so that they can be applied to multipoint recorders or low-speed scanning or data-reduction systems equally easily. However, if we are to use a scanning system, scanning controller, or print out system having a high rate of scan, say 300 to 600 points a minute, then the d-c system transducers are superior.

Abstracted from ISA Paper 56-28-1.

Photo-Stencil Dial Faces

Fig. 1. Jas. P. Marsh dial plates used on company's pressure and temperature instruments. Prior to introduction of photographic stencil techniques, conventional printing methods often necessitated multiple impressions to attain desired opacity. Use of photographic stencil techniques achieves desired opacity with a single impression for each color.

SAM CARLINO
ED NEWMAN
Jas. P. Marsh Co.

Fig. 2. Sam Carlino, company engineer, inspects one of the standard dial-plate silk-screen stencils prepared by the Kodak Ektagraph process. According to Ed Newman, in charge of silk screen operations, use of photographic stencil techniques in printing dial face markings has resulted in long-run economies by assuring predictable results and allowing standardization of handling methods.

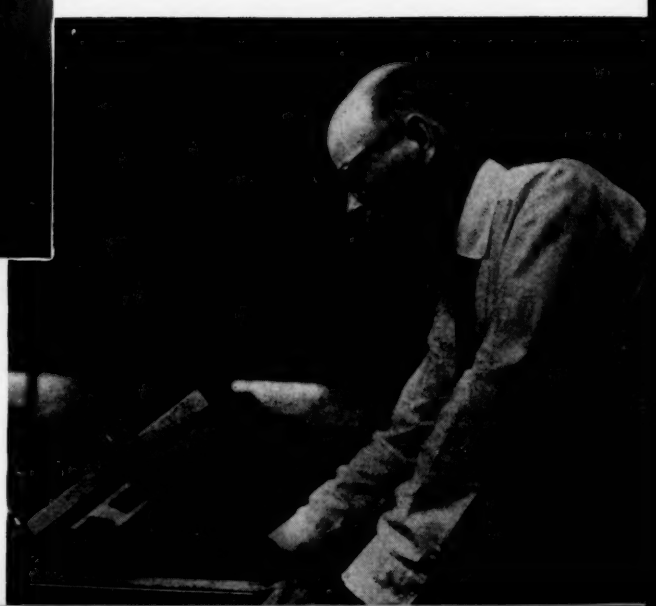


Fig. 3. With a wide range of standard dial-plate screen stencils on file, printing dial faces for a new order necessitates merely placing the appropriate stencil in the silk-screen printing frame and running off the desired number of impressions. Photo shows Newman removing completed dial from the press.

Fig. 4. When a new order comes through, for which there is no stencil on file, a new stencil is prepared by exposing a "positive" of the new marking positioned in contact with Ektagraph film.

Fig. 5. Developing the image takes 75 seconds.

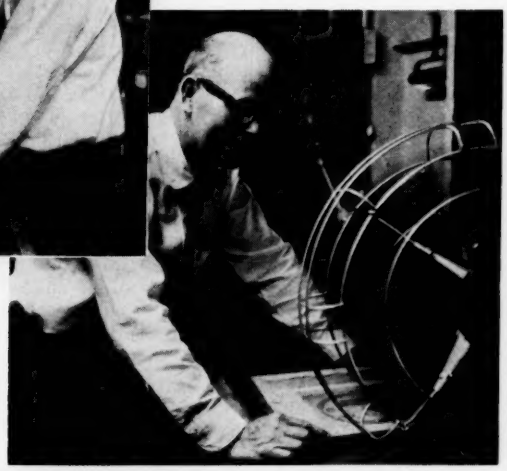


Fig. 6. Newman places the developed film in contact with a silk screen and allows it to dry for five minutes.

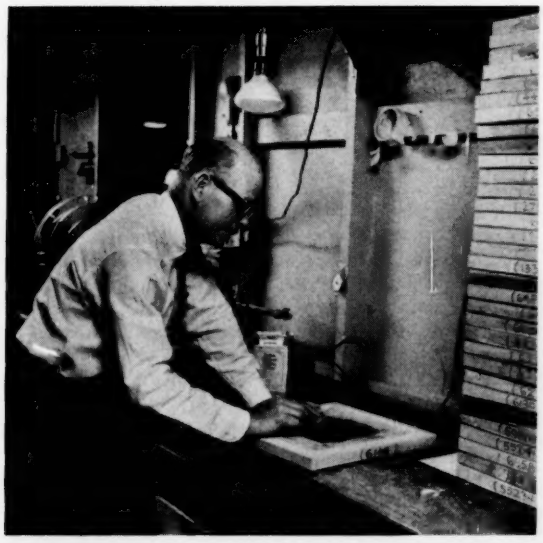


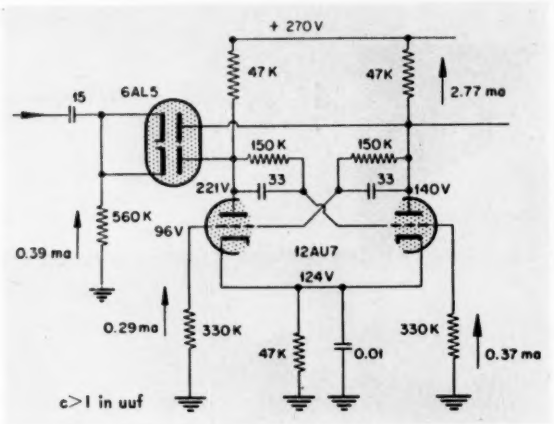
Fig. 7. Gelatin base is stripped from the Ektagraph film leaving the photographic stencil adhered to the silk. The stencil is now ready for printing process.

Fig. 8. The finished product. According to Newman and Carlino, with the trend toward complex, multi-color dial faces, standardized procedures of photoscreen printing make possible considerable economies.

"HARD-BOTTOMED" BINARY SCALER

The term "hard-bottomed" refers to a method of stabilizing tube operation in the conducting state by causing the tube to draw appreciable grid current. In this mode of operation, plate voltage is little affected by changes in grid current and cathode emission which occur during the life of a tube.

Tube life in this circuit is said to exceed 10,000 hours for most tubes. Circuit will also operate with tubes having wide differences in emission and showing unbalance between the two triode sections.



Circuit differs from the flip-flop described previously (*I&A*, Feb. 1955) by the coupling diode, introduced by Higinbotham, which allows the state to be changed by each negative input pulse. Resistor values are chosen to obtain a grid current of 0.28 ma in the conducting triode section. Voltages and currents are shown on the diagram for the condition in which the left-hand triode is cutoff and the right-hand triode is conducting.

When a negative input pulse is applied, the 6AL5 diode conducts, and the pulse appears at the triode plates. Both grids are driven negative via the 33-uuf coupling capacitors. The left-hand triode is not affected, as it is already cut off; however, the negative signal on the grid of the right-hand section starts regenerative action that quickly cuts off the tube, throwing the left-hand triode into conduction (because the grid of the left stage is returned to the plate of the right stage). Circuit voltages are then reversed from those shown.

Note that although the left-hand triode is initially cut off, its plate voltage is considerably below the supply voltage. This voltage drop results from the current drawn through the plate supply resistor (47K) by the diode coupling resistor, and the current drawn by the 150K-330K resistors to the conducting grid.

Circuit will resolve pulse pairs separated by 5 microseconds. Resolution can be improved to 1.5 usec by adding "grid-catching" diodes to limit grid voltage swings.

Input: Negative pulses, 12-v minimum amplitude, duration unimportant, but rise time should be 0.5 usec or less.

Output: 81-v swing, polarity depending on previous state.

Resolution: 5-usec pulse pairs.

Power Supply: 270 v at 3.8 ma; 6.3 v ac at 0.3 a.

Source: C. C. Harris, P. R. Bell and G. G. Kelley, Oak Ridge National Lab., Oak Ridge, Tenn.; also *IRE Transactions—Nuclear Science*, March 1956.

ELECTRONIC

CHARLES F. KEZER
Key Electric Corp.
and
MILTON H. ARONSON
Instruments & Automation

"HARD-BOTTOMED" CLOCK MULTIVIBRATOR HAS 0.1% STABILITY

Accurate timing is obtained in this circuit by operating the conducting tube with a small grid current and with screen current large compared to the plate current. Under these conditions, plate voltage of the conducting tube is of the order of 1 volt, and changes little with tube characteristics (the "hard bottoming" principle).

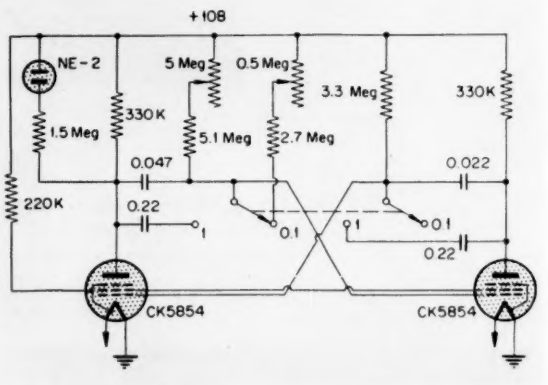


Plate supply voltage is regulated by a VR tube at 108 v dc. Hence the initial voltage on the timing RC circuits, which is equal to the difference between supply voltage and the conducting plate voltage, is held within close limits. (This initial voltage step is the largest factor affecting multivibrator stability.)

Circuit is otherwise a conventional free-running multivibrator. Pulse repetition rates of 1 or 10 per second may be selected by means of the switch, which changes capacitance in both RC circuits. Initial adjustment of frequency is by the two potentiometers (5 meg for the low repetition frequency and 0.5 meg for the higher). For 0.1% stability, the circuit needs readjustment about once every two weeks.

Timing RC resistors are returned to the supply voltage (rather than ground) to provide a steeply rising timing waveform when switching occurs. Temperature-stable RC components should be used in the timing circuit.

Hard-bottomed pentode multivibrators have been found to operate with as little as 0.04% frequency change per percent of supply-voltage change. Variation from tube to tube is much less than 1%. In a similar circuit, miniature tube types 6AK5, 6BH6, 6AU6, 6AJ5 and 6AS6 were

CIRCUITRY

The circuit is the heart of all electronics. Here are 4 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

interchanged, although they are not normally considered as equivalents. Maximum variation in frequency was less than 2%.

Hard-bottomed multivibrators have a tendency not to commence oscillation when power is applied, as both tubes may conduct with loop gain too low for oscillation. This may be overcome by providing a pushbutton to manually cut off one tube temporarily.

Output: Positive pulse, 107 v amplitude; duration approx. 1/3 period (at right-hand plate).

Repetition rate: 1/sec or 10/sec, selected by switch.

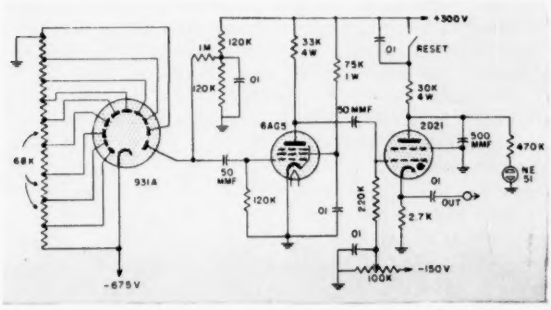
Stability: Needs readjustment once every two weeks for 0.1% stability.

Power Supply: 108 v dc at 1 ma.

Source: C. C. Harris, P. R. Bell and G. G. Kelley, Oak Ridge National Lab., Oak Ridge, Tenn.; also *IRE Transactions—Nuclear Science*, March 1956.

PHOTOELECTRIC TRIGGER CIRCUIT

This circuit was used to trigger a counter chronograph in making projectile velocity measurements. Two accurately defined beams of light (called "light screens") are mounted in the path of the projectile, spaced 10 inches apart (within 0.001 inch). Each light beam is focussed on a separate 931A photomultiplier tube in its own trigger circuit.



When the shell passes through the light beam, the amount of light falling on the photomultiplier is reduced, and its anode current decreases. This reduction of current in the 1-megohm anode resistor produces a corresponding rise in anode voltage. As the base of the shell passes out of the beam, the anode voltage drops abruptly. This negative-going part of the signal is passed through the 50-uuf coupling capacitor to the grid of the 6AG5 amplifier, producing a positive pulse at its plate. This positive pulse is coupled through to the grid of the 2D21 thyratron tube and fires it. Reset switch is a normally-closed pushbutton.

The thyratron, when fired, has a plate-to-cathode voltage drop of 8 volts; balance of the 300-v dc plate supply is divided between the 30,000-ohm plate resistor and the 2700-ohm cathode resistor, with 24 volts appearing at the cathode. The rising portion of this output is coupled through the 0.01-uf capacitor to a counter chronograph; output of the first light-screen trigger circuit turns on the counter gate, and output of the second turns it off, stopping the count.

The thyratron is used in this circuit to prevent the circuit from giving a second output if a particle of unburned powder should pass through the light screen. Once fired, the 2D21 remains conducting until the Reset switch is momentarily opened, disconnecting the plate supply voltage. The NE51 neon lamp is lighted when the thyratron has been reset; it goes out when the tube fires because the voltage drop across the 2D21 and cathode resistor is too small to sustain it.

Deceleration of projectile upon striking armor was also measured—by double-differentiation of a position signal, established as tail of projectile uncovered slit of light. (Differentiation circuit will be shown in the future.)

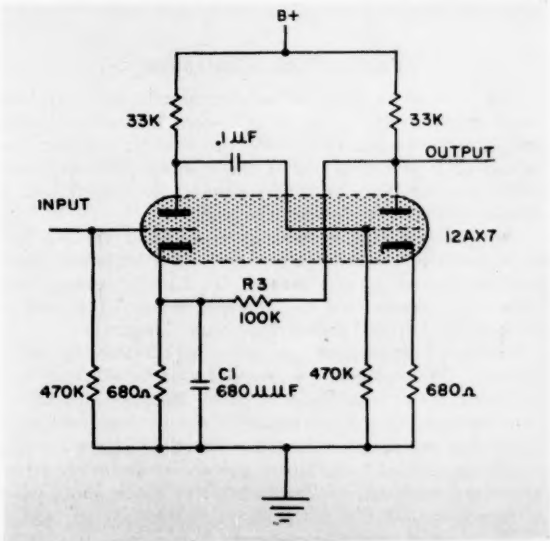
Output: 24-v positive-going pulse.

Power Supply: 300 v dc at 20 ma, —150 v dc at 1.5 ma, —675 v dc at 1 ma; 6.3 v at 0.9 a.

Source: John C. Lindsay and A. Victor Masket, U. of North Carolina, Chapel Hill, N. C.; also *Review of Scientific Instruments*, July, 1954.

WIDE-BAND AMPLIFIER HAS GAIN OF 100 UP TO 200 KC

Feedback is used in this general-purpose RC-coupled amplifier to broaden frequency response and stabilize gain. Feedback via resistor R3 reduces gain by about 10 db, to provide stable gain of 100 which is relatively independent of tube and power-supply variations. Capacitor C1 decreases feedback at high frequencies to extend pass band. Frequency response may be modified by other frequency-compensation networks.



Input: 0.3 v peak-to-peak maximum.

Gain: 40 db voltage amplification (factor of 100).

Frequency response: 1 db from 9 to 200,000 cps.

B Supply: 200 v at 2.5 ma.

Source: Circuit Z-8324, EECO Production Co., 827 S. Vermont Ave., Los Angeles, Calif.

AUTOMATIC LOAD CONTROL

The highly fluctuating load demand of the electric furnaces at Allegheny Ludlum Steel Corporation's works in Brackenridge and West Leechburg, plus the fact that a combined load is billed, necessitated a control system to cut down the demand peaks. Savings are estimated at 20,000 kw (approximately $30,000) per month.

C. A. SCAMMON

Allegheny Ludlum Steel Corporation

IF you are a customer of a power company, your power bill is based on two factors—(1) your maximum power demand for some fixed period and (2) the actual kilowatt-hours consumed.

The power rate which we are being charged at Allegheny Ludlum is more realistic than most; the rate states exactly what part is demand charge and what part is kilowatt-hours or energy charge. Our load, like most mill loads, is highly fluctuating, with the electric furnace loads the greatest offenders.

Some years ago we began to question the haphazard way power was used and the peak demands created. Ever since, we have tried to control the peak with the primary objective of saving money on the power bills.

Power Peak Controller

The electric furnaces were singled out, not only because they are the greatest offenders but also because they are the easiest to control. An electric furnace can be cut back or cut off for a few minutes without harm to the product, but a rolling mill can't be cut off with a strip only partially through the mill.

Our problem was necessarily two-fold. First, we had to measure the load on the same basis the power company measured it, and second, we had to control and reduce the peaks. We did this by means of a system worked out by the Leeds & Northrup Company.

Our first requirement was to set up a system to meter the load. The problem was complicated by the fact that the loads of the West Leechburg and Brackenridge works are combined and measured by a single meter although the plants are about eight miles apart. We have enough synchronous load to maintain any power factor we wish. Therefore, once set, we need not worry much about power factor.

The greatest part of our power is purchased at 25000 volts. West Leechburg has a single meter point, while Brackenridge has four. In order to measure and record the demands, we installed Sangamo thermal converters at each 25-kv metering equipment. These converters connect to potential and current transformers just as one would connect a polyphase meter. The output is a d-c signal in millivolts, proportional to the load being measured.

At West Leechburg one of these thermal converters feeds into a Speedomax recorder, which contains a pulse-type retransmitter which transmits this record to a similar meter at Brackenridge (over leased telephone wire) where it is combined with the Brackenridge load to give the total load of the two plants. The retransmitter chosen was the "pulse" type which can be used for telemetering by telephone circuit, carrier current, or radio. The pulses are sent at 2½-second intervals and the length of the pulse depends on the load. By measuring the charge on a network of resistors and capacitors, the meter at Brackenridge interprets the signals and records them so that it duplicates the West Leechburg chart.

The power company transmits the output of the thermal converter over a pair of telephone wires directly to a meter at Brackenridge, where the load is recorded. As the output of the converter is only a few millivolts, and as the signal had to go through 3 telephone exchanges and 20 miles of telephone pair, frequent interruptions occurred on the line which, we felt, we could not tolerate. Hence we added a 125-volt d-c relay to provide enough voltage to drive through almost any bad connection.

At Brackenridge the outputs of all the thermal converters are connected in series and fed into a Speedomax recorder, similar to the one at West Leechburg, thus furnishing a record of all power metered at the Brackenridge Plant. Additional taps are taken off the thermal converters for metering the power to the two melt shops via two more Speedomax recorders. These recorders were originally installed to distinguish which melt shop was contributing more to the demand peak and to cut it back first. In practice it turned out the the load fluctuations were such that it was impossible to determine the offender with any degree of accuracy. Finally the relays were reconnected to cut back equally on both shops.

Each recorder is equipped with a slidewire retransmitter to show the operator of each furnace the total load —both his own and the other melt shop's. However, we have found that this feature is of doubtful value.

Both recorders at West Leechburg and Brackenridge are equipped with retransmitters which combine their signals to feed into the "Total Load Recorder." This meter is also equipped with a pulsing device, similar to the pulse transmitter at West Leechburg, except that it has a mechanical drive for the shaft of a counter. This shaft turns only a part or a full revolution for every revolution of the timing disc, depending on the load being recorded. The counter is calibrated to read in kilo-

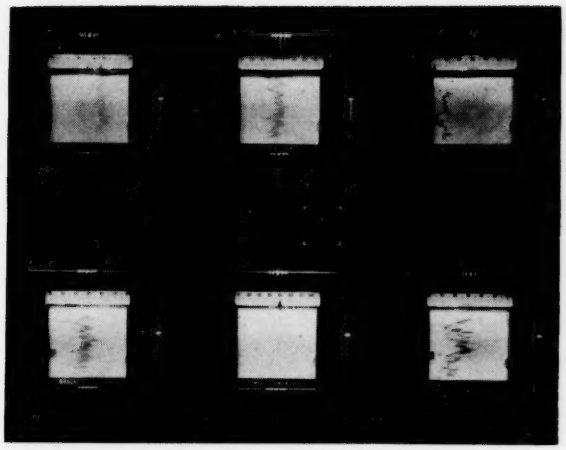


Fig. 1. Control panel.

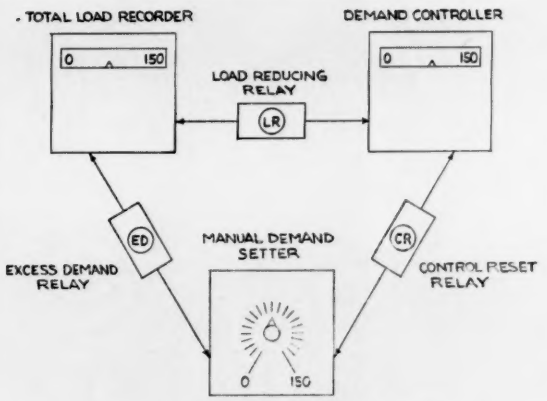


Fig. 2. Control is performed by three electronic relays connected to the various recorders.

watt-hours, the power consumption of both plants. A pair of contacts on the counter shaft is used to feed a signal to the load limiting device.

The Control Board

Fig. 1 shows the control board at Brackenridge. The West Leechburg meter is in the upper left-hand corner. The reading on this meter is telemetered over telehpone wires from the West Leechburg plant where the load is measured and recorded on a similar recorder. Under this recorder is the Brackenridge-plant meter, which records and totalizes the outputs of all the thermal converters in the Brackenridge plant. In the center of the top row is the "Total Load Recorder," which combines the loads shown on the West Leechburg and Brackenridge meters, giving the resulting instantaneous load for the two plants. It also integrates the total kilowatt hours consumed by the two plants. The integrator dial can be seen just above the center of the indicating scale. A pair of contacts attracted by the integrator drive shaft retransmits the integrated load to a timer in the load control unit. The two recorders on the right-hand side measure and record the load of the 8/3 and 8/0 Departments, respectively, which are the two melt shops containing the electric furnaces. The instrument in the lower center is the Demand Controller. Above this meter and below the total load recorder is the Manual Demand Setter. It has the same range (0-150 megawatts) as the Total Recorder and the Demand Controller. In normal operation the reading on the Demand Controller is the same as the setting on the Manual Demand Setter.

Three of the units in Fig. 1 (the Total Load Recorder, the Demand Controller, and the Manual Demand Setter) together with three electronic relays and two timer units (which are hidden behind the panels) constitute the control mechanism which limits the peak demand.

The Control System

Fig. 2 shows how the control units are tied together. An electronic relay, called the Excess Demand Relay (ED), is connected to two slidewire potentiometers, one moving with the dial of the Total Load Recorder, and the other on the main shaft of the manual Demand Setter. When the arm of the potentiometer connected to the Total Recorder passes the setting on the Manual Demand Setter, this relay closes and a load limiting cycle begins.

Two timers located behind the board then start to operate. One operates for a 15-minute period, the unit of time set by the power company for measuring peaks. It measures (at a constant rate) the number of kilowatt-hours as set on the Manual Demand Setter, timing out in exactly fifteen minutes, the time allowed for the load to even out. A second timer (the load unit) actuated by the Total Load Recorder, advances at a rate proportional to the load on the meter. Obviously, if the load on the Total Load Recorder is greater than the setting of the Manual Demand Setter, the second timer will advance faster than the first, and a second electronic relay called the Load Reducing Relay (LR) will close, starting to limit the load.

When the load reading coincides with the setting on the Manual Demand Setter, a third electronic relay, the Control Reset Relay (CR), resets the entire mechanism. When relay CR operates, all control ceases, and a reset relay at each furnace closes, returning the motor-operated rheostats to zero and the furnaces to full load.

Results

The rate is set up so that it costs Allegheny Ludlum $1.97 gross per KVA of demand for the first 15000 KVA and $1.67 gross for each KVA thereafter, with a 2% discount on the entire bill; thus savings of about $1.64 per month per KVA demand saved can be accomplished.

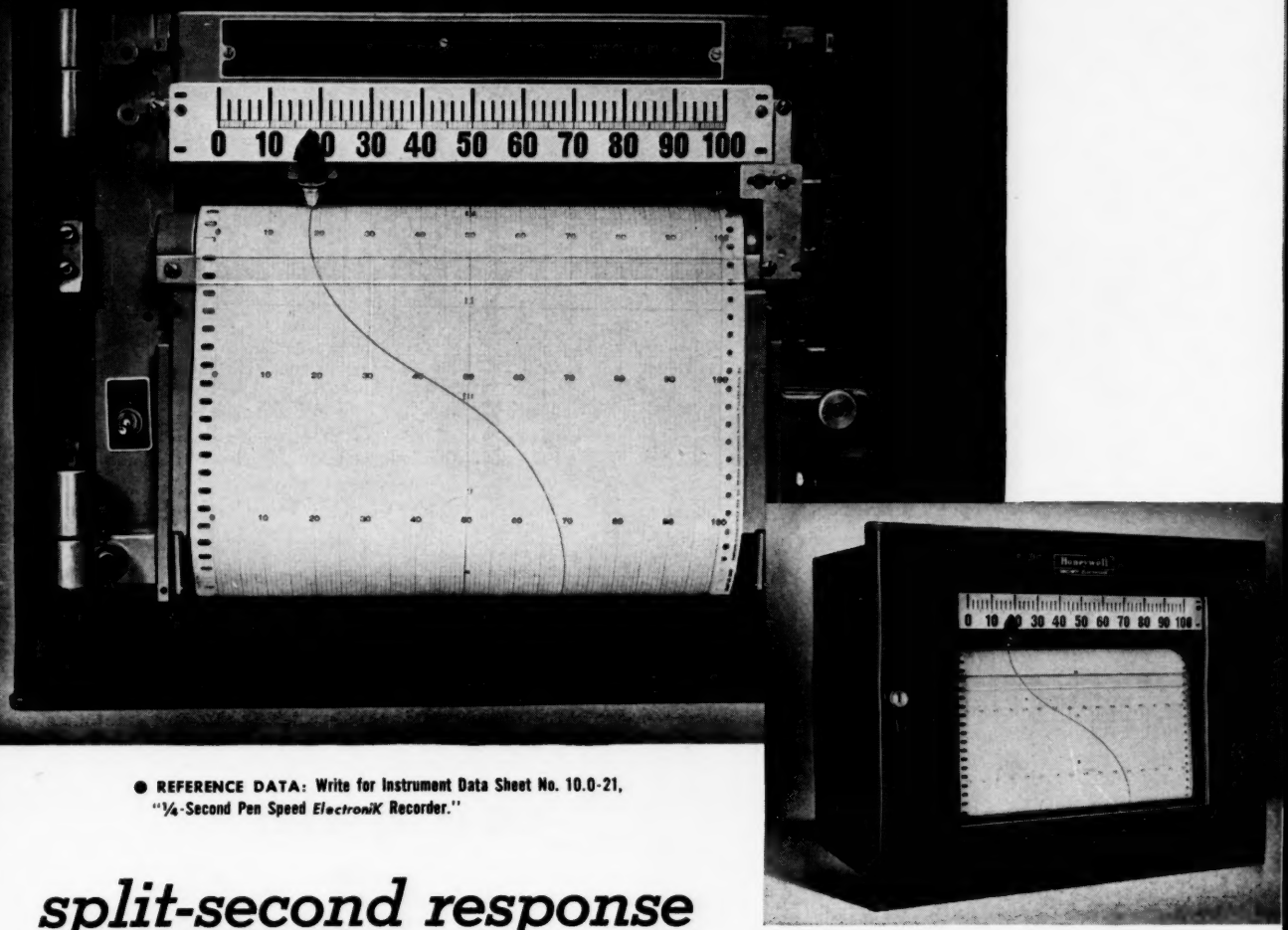
As nobody dares to shut off the control long enough to find out what the demand would be without control we have to estimate by going back into ancient history. Before the control system was installed, several peaks above 90,000 KVA were recorded. Since then the Hot Strip Mill was rebuilt (which added a connected load of 23,750 hp), a Tandem Mill was added with a motor load of 9000 hp plus a lot of auxiliaries, and annealing and processing lines with a total active load of 5000 to 6000 kw were added, while West Leechburg has stepped its load up to 4000 to 5000 kw. If this growth is analyzed it doesn't sound unrealistic to say that close to 20,000 kw per month in demand are saved, which at $1.64 per kilowatt amounts to well over $30,000 per month.

New 1/4-second *ElectroniK* recorder

follows fast-changing variables with

Outstanding new features:

- Simplified design
- Improved damping
- High input impedance
- Continuous standardization



● **REFERENCE DATA:** Write for Instrument Data Sheet No. 10.0-21, "¼-Second Pen Speed *ElectroniK* Recorder."

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DESIGNED to meet the special data-recording requirements of experimental stations, laboratories, and research centers, the new ¼-Second Pen Speed *ElectroniK* Recorder fills an important gap between conventional large-chart recorders and oscillographic instruments.

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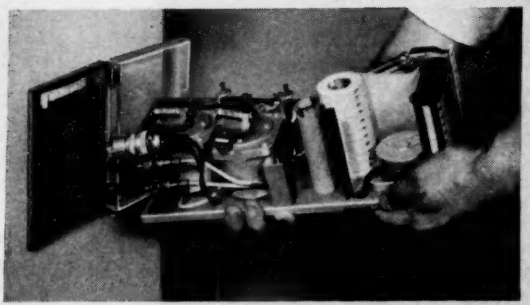
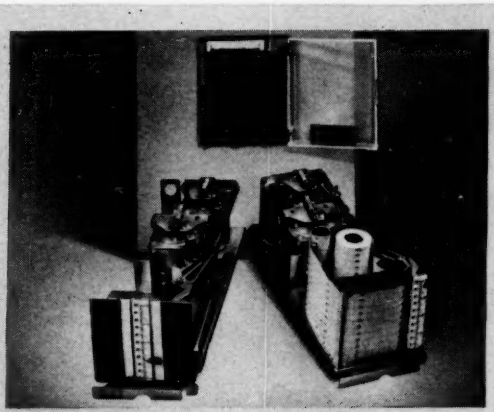
BROWN INSTRUMENTS
First in Controls

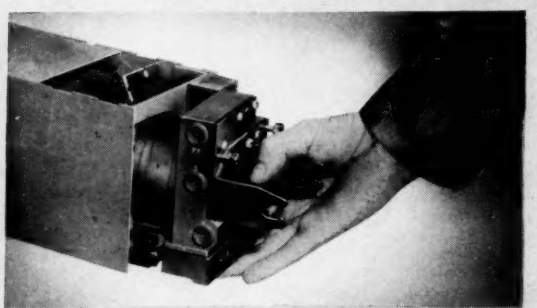


Easily Serviced—All parts can be inspected during operation, without process interruption. To remove chassis completely, unscrew three finger-tight, self-sealing connections.

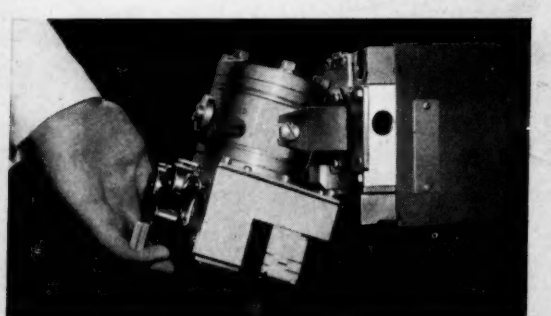


Interchangeable Chassis—Change recorder to indicator or vice versa without interrupting control. Simply pull out chassis, slide another in place.

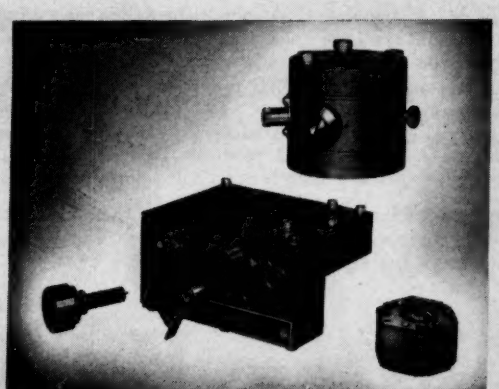
Now you can gain ... *Extra*



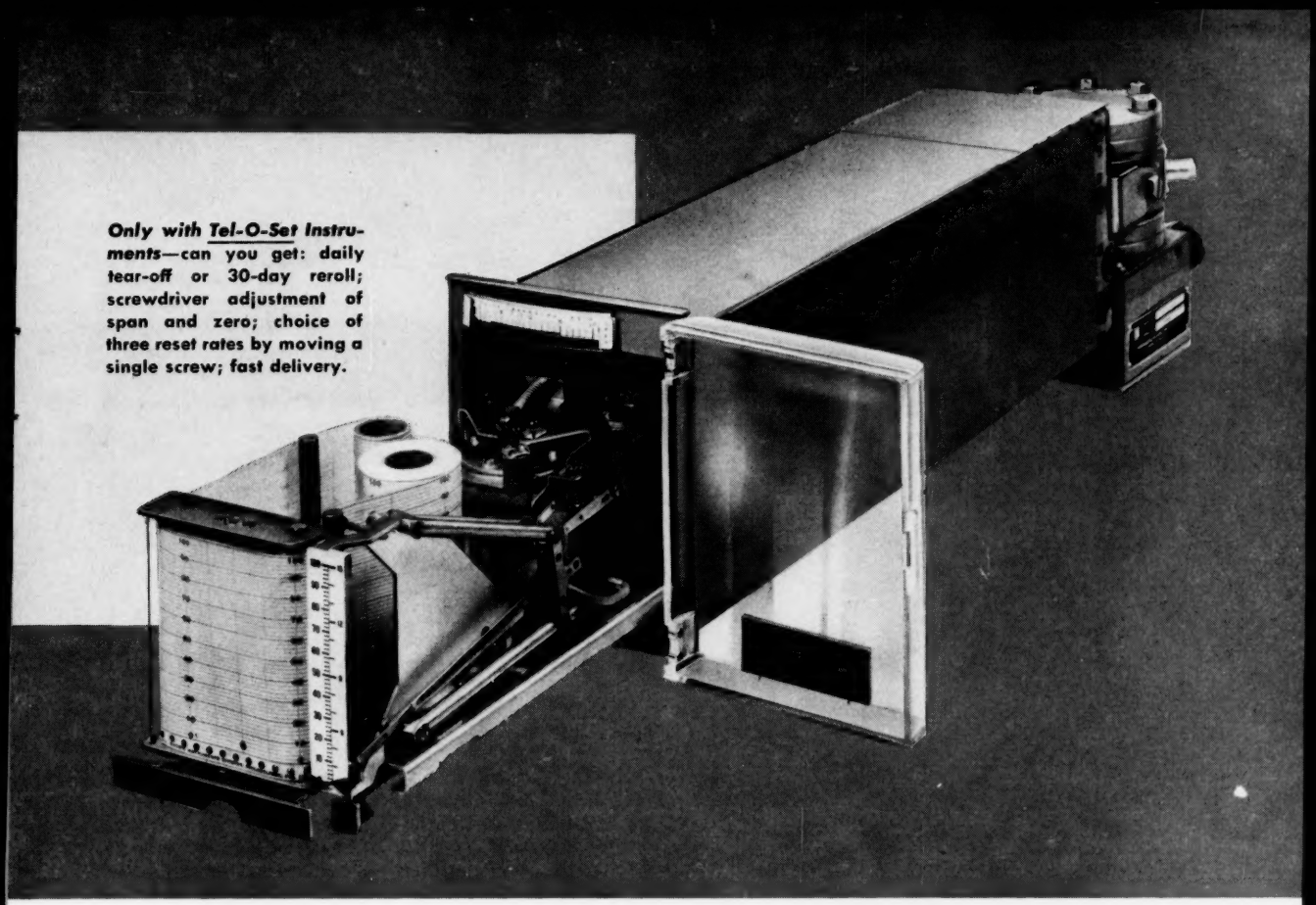
Removable Regulator—Pneumatic assembly, consisting of regulator and switches, can be removed from rear of case without disturbing electrical connections—no need for an electrician to stand by.



Quick-connect Mounting—Controllers have quick-connect switch permitting removal of the unit while process remains on manual control.



Easily Disassembled—Unitized construction of all controller components simplifies maintenance . . . makes reassembly foolproof. No need to dismantle stack to clean pilot assembly.


Only with Tel-O-Set Instruments—can you get: daily tear-off or 30-day reroll; screwdriver adjustment of span and zero; choice of three reset rates by moving a single screw; fast delivery.

Savings with TEL-O-SET*

. . . advanced miniature pneumatic instruments

Tel-O-Set miniature instruments accurately record, indicate, and control process variables. They're applicable to any process variable . . . a savings in itself. And, further savings are accrued from these factors: Only a few models are needed for *all* applications . . . Personnel training time is minimized . . . Spare parts inventory is reduced . . . Process techniques can be changed without buying new instruments. The photographs point up some of the outstanding *Tel-O-Set* features.

For complete information on *Tel-O-Set* instruments, write for Catalog C 1001-1, or call your nearby Honeywell sales engineer. He's as near as your phone.

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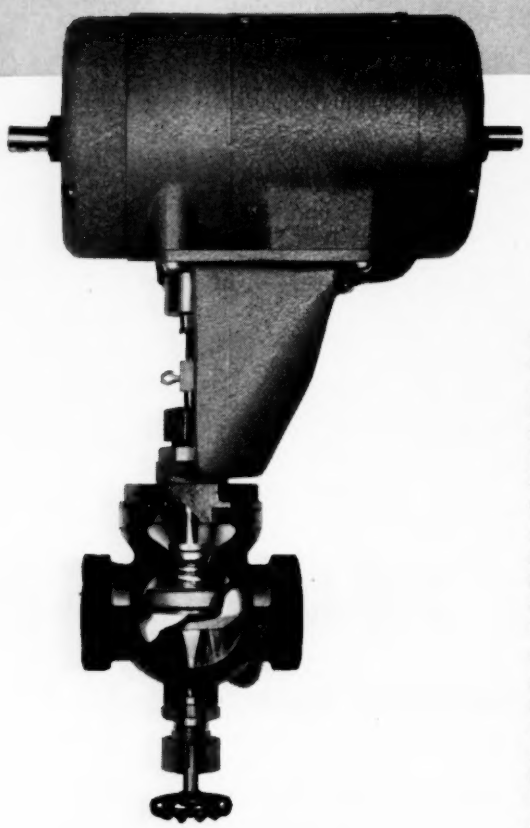
MINNEAPOLIS **Honeywell**

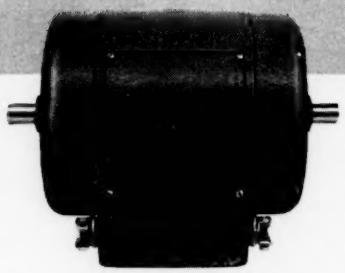
BROWN INSTRUMENTS

First in Controls

NEW ACTIONATOR*

heavy duty electric motor for operating valves, dampers, louvers





The new Honeywell ACTIONATOR* is a compact, lightweight, rugged and flexible industrial motor for operating valves, dampers, louvers, and other final control elements. Models for boss mounting or with integral valve yoke for installation on slip stem valves. Internal strain release protects valve seats and gear train. Squared shaft ends facilitate actuating lever attachment.

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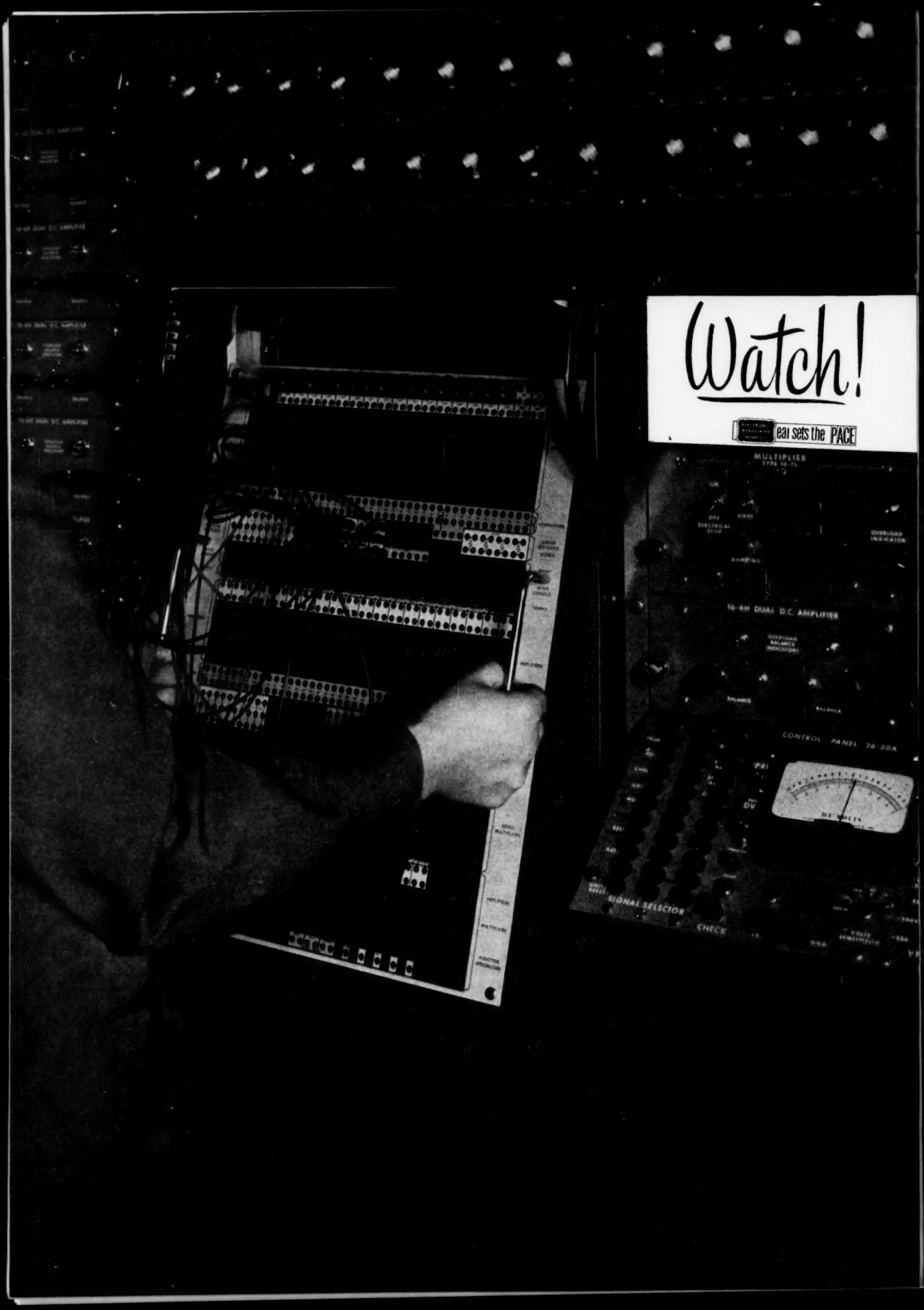
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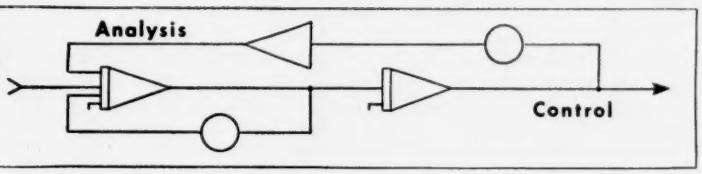

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Bits

Short *Newsletter* this month because your Editor has just returned from the LSU High-Speed Computer Conference, which is mentioned briefly under *Info*. Also under *Info* are other miscellaneous bits of information about activities in the computer field.

Under *Pieces* there is a brief summary of the meeting of the Western Simulation Council on the "Generation of Functions of More Than One Arbitrary Variable." This writeup is brief because the talks presented by both speakers, Bill Kindle and Hans Meissinger, were based on papers which are available elsewhere for those interested in the details. If I am able to think of one some time between now and the end of the *Newsletter*, I will close with a Thot for the month (whether it is worth printing or not!).

Pieces

Western S/C Meeting of 10 January on "Generation of a Function of Two or More Variables"

Sixty-three representatives of 28 organizations attended the meeting of the Western Simulation Council held at the EAI Computation Center, 1500 East Imperial Highway, El Segundo, California on the afternoon of Thursday, 10 January, to discuss the generation of a function of two or more arbitrary variables.

Kindle on Analytic Procedure

Bill Kindle, who is in charge of the Center, spoke on "An Analytic Procedure for Approximating Functions of Two Variables with Sums and Products of Functions of a Single Variable."

Bill's technique takes advantage of the fact that functions of two variables having nearly parallel contours can be approximated by the addition of functions of single variables; i.e., $f(x,y) \approx g(x) + h(y)$, and that functions of two variables having nearly proportional cross-sections can be approximated by the multiplication of functions of single variables; i.e., $f(x,y) \approx g(x)h(y)$.

Bill demonstrated an iterative method of determining the values $g_1, g_2, \ldots g_n$ and $h_1, h_2, \ldots h_n$ to construct a double-entry table. Values from this table then can be used to set up padded pots to perform the addition or multiplication necessary to generate the desired function. Bill says that with practice a desk calculator can be used to generate a table in about half an hour.

This is a particularly useful technique for certain equipment specifically designed to facilitate the setup and use of tapped pots. However, like all servo-actuated equipment it does suffer from the inherent response limitations of the servo. And it is only applicable to certain types of functions.

Bill gave us copies of his report, and though he didn't say so, I'll bet he would be happy to send it to others requesting it.

In the discussion which followed, *Jim Murrin* (J. B. Rea Co., Santa Monica, Calif.) asked if Bill was usually satisfied with the fit his method gave.

Bill answered that if the original function is well-behaved, the results will be good.

Dov Abramis (Convair-Pomona, Calif.) said they try to get functions of two or more variables on the basis of experience. They make a guess and then have the digital machine determine the coefficients for the best

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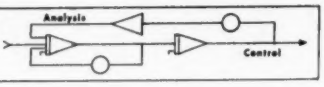


fit, using the least-squares method. Thus the digital machine does all the dirty work required to generate set-up information for the analog.

Fred Williams (Hughes Aircraft Co., Culver City, Calif.) said that he had tied the digital computer into the equipment and let it do its "thinking" on the spot.

Meissinger on Use of DFG

The second speaker was *Hans Meissinger* of Hughes Aircraft Company, whose subject was "The Use of Diode Function Generators* for Functions of Several Variables."

Hans' method is an extension of the well-known diode method of generating a function of one variable by a series of straight-line segments so that $z \approx f(x)$. In its simplest form, Hans' method for generating a function of two variables supplies the diode network with a variable voltage y instead of a constant bias voltage as in the case of a single variable. This has the effect of shifting all break points proportionally and all line segments parallel to themselves to generate the function $z \approx f(x,y)$. As this simple method is only applicable to certain classes of functions, Hans extends the method (and unfortunately the complexity) to:

(a) cases where the break points are not shifted linearly with y, by supplying the diodes with appropriate bias voltages $g(y)$ instead of y;

(b) cases where the loci of break point shift are not inter-related (i.e., where they do not constitute a family of projectively related curves) by supplying $g_1(y)$, $g_2(y)$, etc., to individual, or individual groups of diodes;

(c) functions of more than two variables, by cascading generators.

In conclusion, Hans demonstrated a graphical method for determining the bias functions, $g(y)$. This method, described more fully in Hans' paper presented at the IRE National Convention in New York City in March 1955, is quite good for a variety of functions $f(x,y)$ encountered in practical applications. However, for others it demands considerable ingenuity and a good bit of equipment.

It is interesting to note that Hans' technique of cascading generators to produce a function of several variables is applicable to systems not employing diode networks.

*Manufactured by Reeves Instrument Co.

Hans also mentioned another method of generating functions of more than one variable as described by *George Philbrick* in his article "Continuous Electronic Representation of Nonlinear Functions of n Variables", published in his *Palimpsest on the Electronic Analog Art* and in Korn & Korn's Second Edition of *Electronic Analog Computers.*

In the discussion which followed Hans' talk, *Dov Abramis* said they always found that, because of loading errors and other factors, adjustments always had to be made with diode function generators, even for functions of a single variable; the calculations are a good starting point, that's all. You finally have to put it on a plotting board to get the final settings. Manual fiddling is necessary.

Jack Sherman (Lockheed Missile Systems Division, Palo Alto, Calif.) remarked that they have found this so invariably true that they don't bother to make the calculations.

Jim Murrin said they had avoided using straight-line segments in favor of sine curves, log curves, exponentials, etc.

Hans replied that he preferred linear segments because they are cheapest to obtain and if you break up a curve into sufficiently short segments you can get a better fit.

Fred Williams observed that the advantage of a diode function generator over tapped pots is that if there is a point of particular interest on a curve the available segments can be concentrated in that area with a diode function generator, whereas with a tapped pot this is difficult.

Dov explained that they took care of this by changing gains.

In answer to a final question, *Bill Kindle* reiterated that at the EA Computation Center they do not use the servo-driven tapped pots to generate the complete function, but only that part of it which deviates from linearity. Thus the servo characteristics only affect the deviation from linearity and are second-order effects.

EAI Computation Center Tour

After a break at which refreshments were served, the group was shown around the EAI Computation Center. The computing equipment can be used in two parts or can be connected as a single unit for larger problems.

Each part consists of the following basic components:

- 80 potentiometers
- 60 amplifiers
- 10 multiplying servos, each with 5 multiplying cups
- 8 pot padders to generate non-linear functions
- 3 resolvers, each with 2 sin-cos cards and 3 multiplying cups
- 4 diode function generators
- 1 xy plotter 10" x 17"
- 1 six-channel recorder
- 1 digital voltmeter
- 1 noise generator

In addition, a rack consisting of five electronic multipliers, each multiplying a variable by two others, and a 30 x 30 two-pen plotting board, are available.

This equipment may be rented at the following rates:

One basic computer	$45.00 per hour
Electronic multiplier rack	7.50 " "
Two-pen 30" x 30" xy plotter	5.25 " "
Both basic computers (inc. plotter)	90.00 " "

The computers have the new automatic extended read-out feature which prints out on tape the voltages appearing at the output of all amplifiers, multipliers, resolvers, diode function generators, and selected potentiometers and trunk lines. Also, a new problem-check feature provides for reading the value of the derivatives at all integrators, and these may be printed out through the read-out equipment.

Engineers are available for problem setup and computer operation at $15.00 per hour.

Information (Without Theory)

The Fourth Annual High-Speed Computer Conference at Louisiana State University, Baton Rouge, March 5 through 8, got off to an interesting start with "The Expanding World of Computers" by *John W. Mauchly* (Remington-Rand UNIVAC Applications Research Center, Philadelphia, Penna.) and "Automatic Computers" by *Howard Aiken* (Director, Computation Laboratory, Harvard University, Cambridge, Mass.).

Although this conference had a strong business-data-processing fla-

vor, there were some papers which were, or should be, of interest to simulation people.

Dr. Aiken, and later *Dr. Gardner Jones* (Assistant Professor, Michigan State University, East Lansing, Mich.) in his talk "Computer Education: Dilemma of the Colleges," showed an awareness of, and suggested some solutions for, our acute problem of educating people, on the one hand to appreciate the capabilities and uses of computers, and on the other to operate them.

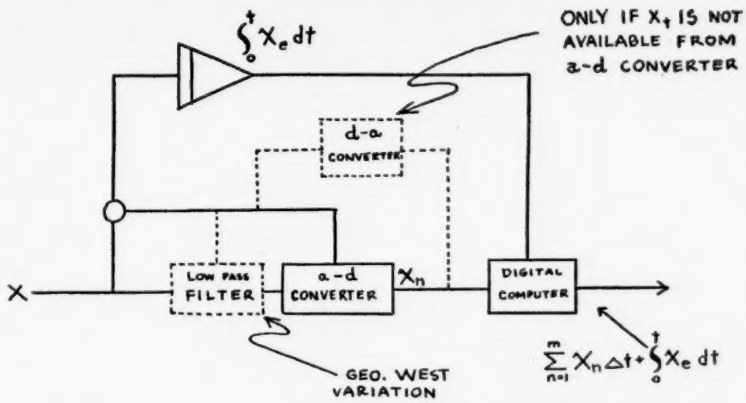
Your Editor presented a paper coauthored with *Bob Leger* (Convair-Astronautics, San Diego, Calif.) on "Combined Analog and Digital Systems: Why, When, and How" in which he discussed the capabilities and limitations of each kind of equipment and showed under what circumstances a combined system should be considered; which parts should be analog and which digital; and what kind of equipment is or may be available for analog-to-digital-digital to-analog information conversion. This paper will be published in an early issue of *I&A*.

West on Combined Ana-Dig Techniques

The next talk was "Combined Analog and Digital Techniques" by *George P. West* (Ramo-Wooldridge Corp., Los Angeles, Calif.) who, after summarizing some of the points previously made, generalized by discussing computational areas in which a combination of techniques can yield a more powerful method than is possible with either all-analog or all-digital techniques.

As an illustration, George used the process of integration, which is done rapidly but with limited accuracy by analog means, whereas digital methods can be made to yield practically any desired accuracy, but only by trading time for it.

George described a method, which he credited to *Jerry Greenstein* and *Bob Leger* (both of Convair-Astronautics), which combines analog and digital integration to produce a system both fast and accurate. In this method an analog voltage X is sampled and digitized to give a number X_n, which is operated on by a digital integrator to yield $\sum_{n=1}^{m} X_n \Delta t$. An analog voltage X_t equal to X at the time of sampling is obtained either from the internal feedback loop of the a-d converter or from a d-a converter operating on X_n. This voltage is continuously compared with the input voltage X to produce an error voltage X_e which is integrated by an analog integrator to yield $\int_0^t X_e dt$.



This quantity is then digitized and added to the digital integral to give

$$\sum_{n=1}^{m} X_n \Delta t + \int_0^t X_e dt.$$

The advantage of this method is that the rates of change of X which are high with respect to the integrating interval Δt are taken care of by the analog integrator. At the same time the analog integration errors are minimized because the analog integrator only operates on the error signal X_e and not the total quantity X. For a given accuracy this allows larger intervals and therefore more digital computer time for other operations.

George also mentioned a variation of this technique they are experimenting with at Ramo-Wooldridge in which he precedes the a-d converter with a low-pass filter (see illustration) and derives his error signal between the input and output of the filter. This has the effect of splitting the frequencies and treating the high ones with an analog integrator and the low ones with the digital computer. The characteristics of the filter should be matched to the method of digital integration, George said. As before, the output is a composite of the two integrals.

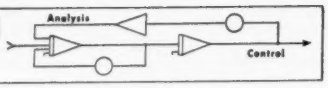
In real-time combined simulation digital computer time will probably be at a premium. In some cases, therefore, it might be advantageous to run the a-d converter operating on $\int_0^t X_e dt$ at some multiple of the rate of the converter operating on X because the digital computer only adds the former output (a comparatively fast operation) whereas it must multiply as well as add the latter. For a given overall accuracy some saving in digital computer time may thus be realized.

George showed a graph of total error in percent of analog error, plotted versus the size of digital integrator steps in degrees of a sine wave input, for various methods of digital integration. The simple step method, as may be expected, yielded rather high errors even for comparatively small steps, but the errors did not increase as rapidly with step size as did the errors of the higher order prediction techniques (which were very good for small increments but went to infinity for larger ones). The combined analog-digital system, on the other hand, yielded very small errors in the beginning, which increased to 100% of the analog error as the steps approached 180°, the maximum size step which information theory allows. This, of course, is what would be expected because (1) as the size of the digital computational increments approaches zero the digital error will approach zero, whereas (2) as the size of the increments approaches 180° the analog integrator will be doing almost all of the integrating and the total error will approach the analog error.

George emphasized that he merely used this as an illustration of one particular operation which can be improved by combined techniques. The same principle can be applied to other areas in which either analog or digital equipment has difficulties when used alone.

Other papers of particular interest to Simulation people were "Application of Digital Computers to Electric Power System Loss Studies" by *E. E. George*, Ebasco Services, New York; "Digital Programming and Read-Out for Analog Computers" by *D. R. Miller*, Berkeley Division of Beckman Instruments, Richmond, Calif.; "Applications of Large Computers to Reservoir Engineering Problems" by *D. G. McCarty* and *D. W. Peaceman*, Humble Oil & Refining Co., Houston, Tex.; "Fractionation Design on Medium-Size Electronic Computers" by *R. L. McIntire*, Datics Corp., Fort Worth, Tex.

SIMULATION COUNCIL



• We received a press release which reads in part as follows:

"An analog computation center will be opened in Brussels, Belgium during the early summer of 1957 by Electronic Associates, Inc. of Long Branch, New Jersey, U. S. A. The center will provide the very latest types of electronic analog computors, as well as a staff of scientists for problem analysis and programming. The equipment and staff of this center will be available for rental on an hourly, weekly, or monthly basis."

"One of the chief values (of such a center) lies in the savings of precious engineering time in this day of a shortage of engineers and scientists."

"Plans are to staff the center with as many European scientists as possible."

"It is hoped that this computation center at Brussels will accelerate the European interest in analog computers to the same degree that it has grown in the United States."

* * *

• Midwest Research Institute has published the proceedings of last year's Symposium for Management on the Industrial Applications of Analog Computers. The 210-page publication contains 13 technical papers plus the transcript of round-table discussion. Priced at $5.00, it may be ordered from Midwest Research Institute, 425 Volker Boulevard, Kansas City 10, Missouri.

* * *

• We are pleased to note that both the Midwestern and Central Simulation Councils are planning to hold their April meetings in connection with the IRE-sponsored National Simulation Conference at the Shamrock Hotel in Houston, Texas 11-13 April. The Simulation Council meetings will be on Thursday evening, the 11th. In addition, *Bob Howe*, the new Chairman, has called a meeting of his International Simulation Council Steering Committee for the same time and place.

We have just been going over our copies of the program, and all in all it seems this should be a most interesting Simulation event.

Thot (on integration in the Deep South)

The marriage of the analog and digital computer as advocated at the Louisiana State University High-Speed Computer Conference might be branded miscegenation by some, but the bilingual infant offspring can already lick its parents in some areas.

Computer Events

Seventh Regional Technical Conference and Trade Show —IRE

Dates: 24-26 April 1957
Place: San Diego, Calif.

Subject: "Advanced Work in Flight Simulation Techniques" The Computer Session will be conducted by Dennis Finnegan of the Stanford Research Institute. The session on Data-Handling and Automation will be conducted by Larry Silva of Beckman Instruments. Technical sessions in the U. S. Grant Hotel. Exhibits in Balboa Park.

Eastern S/c Meeting

Date: Friday, May 24th
Place: Westinghouse Electric Corp., Air Arm Div., Friendship Airport, Baltimore, Maryland.
Schedule: 10 AM, Steering Committee; 10 AM, Tour of Facilities; 11 AM, Study Groups; 12 Noon, Lunch; and 1 PM, Technical Sessions.

DDA Council Meeting

Date: Tues. June 11, 1957
Place: Statler—Ivy Suite, New York City.
AM: Tutorial session 10 AM
PM: Technical discussion 1:30 PM

Association for Computing Machinery—12th National Meeting

Dates: 19-21 June 1957
Place: University of Houston, Houston, Texas

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Simulation of
Discontinuity Nonlinearities

Engineers operating an analog computer, or process instrument men analyzing their unit operations, often must simulate nonlinearities. Discontinuity nonlinearity is a term used to describe the type of nonlinear effects associated with abrupt changes of output/input characteristics, such as occur in limiting, dead-band, and hysteresis. Here are various ways of simulating these discontinuity nonlinearities.

DON H. SCHUSTER
Psychological Services, Inc.

A COMMONLY encountered nonlinearity is that arising from a quantity arriving at a limiting value (Fig. 1A).

Diode Limiters

There are several diode circuits which accomplish this simulation. Fig. 1B* shows a conventional limiter in which the input signal is shunted by the conducting diode when the input reaches or exceeds twice the diode bias. The limiting action of this circuit does not have a sharp breakpoint because changeover from high back-resistance to low forward-resistance of the diode takes place over approximately a 1/2-volt range. This effect can be minimized by using relatively high-value input resistors (1/2 megohm is shown). On the other hand, this effect can be used to advantage if a "gentle" approach to limiting is desired (use lower values of input resistors).

The circuit of Fig. 1C limits the output voltage by changing the value of the amplifier's feedback resistor (1 meg, but not shown) when the diode conducts. The diode is connected to a resistance value which is the sum of the resistance from the low-potential end to the arm of the potentiometer and the conducting resistance of the diode. Absolute limiting does not occur in this circuit because the feedback resistance does not become zero; the gain merely changes, usually by a ratio of at least 1/50 at the limiting-voltage point. This can be improved by using greater than one-megohm input resistors or by using a lower pot setting, or both. Note that the lower end of the pot is *not* grounded, but is connected directly to the output terminal of the amplifier. The correct potentiometer setting is *not* linearly related to the desired limiting voltage, but must be found from the expression: $P = 1000\ V_L/(V_L + 100)$ where P is the potentiometer setting, V_L the desired limiting voltage, and 100 v is the (assumed) reference voltage. For example, if the desired limiting voltage V_L is 50 volts, then $P = 100\ (50)/(50 + 100) = 1000\ (50/150) = 1000\ (0.333) = 333$; that is, with a thousand-division dial, the potentiometer would be set at 333.

The circuit of Fig. 1D is similar to that of 1C and is useful where one end of all potentiometers is grounded.

The circuits of Figs. 1C and 1D have another disadvantage; abrupt limiting does not occur. The diode begins to reduce gain when the plate is about 1/2 v from the desired limiting voltage. (Some diodes—6AL5's, for example—are more "abrupt" than others.) The actual voltage when limiting is completed is about 0.2 v above the desired limiting voltage. The performance of these circuits can be improved by using a lower value of feedback resistor (such as 100K) instead of 1 megohm.

Amplifier Limiter

Fig. 1E shows an amplifier limiter which is not a diode type. In this circuit the upper limiting amplifier behaves like the diode in Fig. 1D. When not limiting, the effect of this amplifier on the lower is negligible.

This circuit produces a sharp break point or transition from the non-limited to the limited condition. There is a time lag of about 15 milliseconds for the limiting action transition. (This lag does not occur in the previous three circuits.)

This circuit (Fig. 1E) is used in Reeves and Northrop amplifiers, where output is taken from the plate of the last tube. The direction of limiting action, as well as reference voltage, is reversed for EAI (PACE) amplifiers because output is taken from a cathode follower.

With the exception of the circuit of Fig. 1E, all these circuits can be made to limit at negative voltages by reversing both the reference voltages and diode polarities.

*Convention followed in figures and illustrations: All resistive values are given in megohms, and capacity in microfarads. A rectangle is the symbol for a 1000-division potentiometer; "G" represents the input grid or summing point of the amplifier. Unless otherwise indicated, the amplifier is assumed to have a feed-back resistor of one megohm.

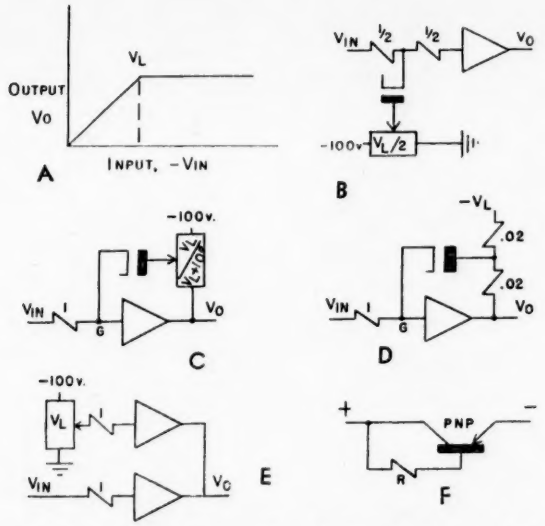

Fig. 1. A, curve representing "limiting" characteristic. V_O is limited at V_L by the five circuits shown in B, C, D, E, and F. Advantage of E is sharper "break point." Transistors (F) have better ratio of forward-to-back resistance than crystal diodes.

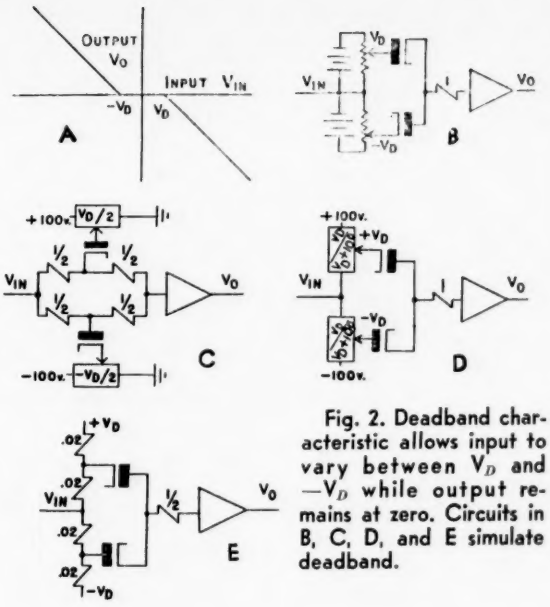

Fig. 2. Deadband characteristic allows input to vary between V_D and $-V_D$ while output remains at zero. Circuits in B, C, D, and E simulate deadband.

To do this the circuit of Fig. 1E requires an additional amplifier as a sign-changer; the circuit will not by itself limit negative-going voltages.

Use of crystal diodes in circuits Figs. 1C and 1D is not recommended due to their relatively low back-resistance; even a one-megohm back resistance will halve the gain. For lower voltages, transistors can be connected as diodes with a much better ratio of forward to back resistance. Thus transistors are suitable in circuits of Figs. 1C and 1D. Fig. 1F shows the manner in which they can be connected for this purpose.

DEADBAND

Deadband is an inert zone in the transfer characteristic (Fig. 2A). It can be simulated by several diode circuits.

Circuit with Isolated Supply

The circuit of Fig. 2B is excellent for representation of deadband, but requires a power supply (or battery) isolated from ground. This can lead to undesirable external wiring, permitting stray capacity and hum pick-up. However, the circuit is simple and introduces no attenuation once out of the deadband region.

Circuits with Grounded Supplies

Fig. 2C illustrates a counterbalanced deadband circuit. In the deadband region both diodes conduct, but in such a manner as to cause equal and opposite input voltages to be applied to the amplifier. Outside the deadband region, one diode no longer conducts, which allows the signal to reach the grid point of the amplifier. This circuit has the advantage of using a grounded power supply and does not attenuate the signal.

Figs. 2D and 2E illustrate different aspects of the basic circuit of Fig. 2C, and permit grounded power supplies or batteries. Their major disadvantage is that they require a small loss in signal for the voltage division necessary to produce the deadband bias.

The circuit of Fig. 2E requires somewhat more loss because amplifier input resistance is one megohm plus diode conducting resistance, a total of about 1.1 megohms. This attenuation can be compensated by appropriate gain supplied elsewhere—e.g., changing the amplifier feedback resistor. These last two circuits are readily converted to hysteresis simulation, as discussed, next.

None of these circuits produce sharp corners at edges of the deadband region, due to the approximately half-volt transition region of the diodes. More abrupt diode action can be obtained by using crystal diodes in series with hot diodes.

HYSTERESIS

Hysteresis (Fig. 3) is a nonlinearity similar to deadband. Backlash in a gear train is a good example of hysteresis—regardless of angular position, any reversal of motion has to take up the slack before output again follows the input. This is to be contrasted with deadband where nonlinearity occurs only at the origin.

With slight modification, the circuits of Figs. 2B, 2D, and 2E can be used for hysteresis; that of Fig. 2C cannot.*

The circuit of Fig. 3B is similar to the series deadband circuit of Fig. 2B, but input and feedback impedances of the amplifier are now capacitors. These capacitors permit operation of the amplifier about an arbitrary voltage reference (amplifier input and output need not be referred to ground, as in a sign-changer).

Differentiation (provided by the input capacitor) followed by integration (provided by the feedback capacitor) is the same as straight amplification. However, the constant of integration depends on input voltage

*The reason why the circuit of Fig. 2C cannot be modified for hysteresis is this: One of the diodes is always conducting; this prevents the input capacitor from accumulating a charge proportional to the input voltage, as is desired. The circuit of Fig. 2C can be used in the arrangement of Fig. 3E, if desired, because the reference for the diodes always is ground.

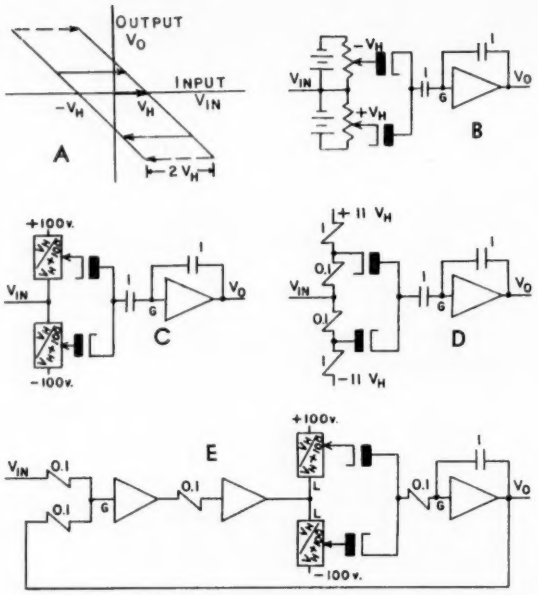

Fig. 3. Hysteresis nonlinearity occurs with every direction reversal of input current. The four circuits shown develop hysteresis-cycle outputs, and are mainly adaptions of the deadband circuits. Note that B, C, and D can be considered differentiation followed by integration.

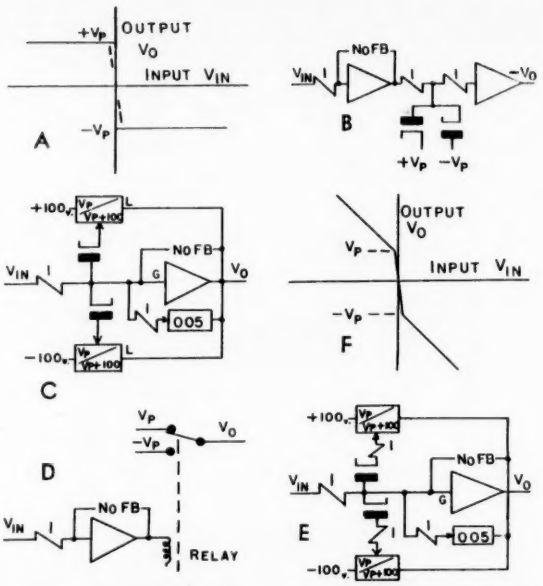

Fig. 4. Coulomb friction, or preload, characteristic (A) is developed by circuits B, C and D. Combination of coulomb and viscous friction is simulated by circuit E, with characteristic shown at F.

and "deadband" bias, which permits simulation of hysteresis or backlash.

The circuits of Figs. 3C and 3D use the two types of shunt voltage feed shown in Figs. 2D and 2E, followed by a differentiator-integrator amplifier. High-quality capacitors are used in this type of circuit to prevent drift in output voltage.

Fig. 3E shows a closed-loop method of simulating hysteresis. Drift is limited to the total amount of backlash, or deadband, in the hysteresis. As each cycle in the hysteresis loop is completed, this drift is cancelled. However, drift in modern analog-computer integrators is small; hence use of Fig. 3E circuitry is probably not justified (on this basis) for runs under one hour. The circuit in Fig. 3E is appropriate for small values of hysteresis because any change in the input voltage is multiplied by a factor of about one-hundred before it reaches the diodes.

COULOMB FRICTION and PRELOAD

Coulomb friction, spring preload, and reversible step voltages can be simulated by diode-amplifier combinations in several ways. Fig. 4A shows the output/input characteristic for Coulomb friction.

Fig. 4B shows a high-gain amplifier (no feedback resistor) feeding a diode limiter. The diode bias voltages are set at desired step heights (not one-half, as for limiting; see Fig. 1B). If no output is wanted with zero input, the gain can be reduced from its open-loop value, by means of a feedback pot, until this occurs with stability. The circuits of Figs. 4C and 4D show such a feedback pot. The gain, when this feedback pot is used, is given by the reciprocal of pot setting times input resistor, $1/(1)\,(0.005) = 200$.

A disadvantage of the circuit in Fig. 4B is that the high-gain amplifier saturates quickly for non-zero input voltages. For example, using Reeves computers, this amplifier would have to be operated with its zeroing switch in "Manual" to facilitate fast recovery from saturation.

Fig. 4C shows a circuit for preload whose one amplifier is limited to provide the $\pm$ steps output. This permits the amplifier to be operated without manual zeroing because it never reaches saturation. The feedback pot is helpful in providing a stable neutral output by controlling gain.

Fig. 4D shows a relay circuit for preload.

Frequently it is desirable to simulate the combination of coulomb and viscous friction, or the combination of spring preload and spring force. A convenient circuit for doing this is shown in Fig. 4E.

RELAYS

For those rare cases where it is desired to simulate the action of a relay switching the same voltage that controls it, a combination of deadband and preload works nicely. This switching characteristic is shown in Fig. 5A, and a relay circuit to produce this in Fig. 5B. The relay pulls-in at a voltage V_D, which is transferred to the output and called V_o. A diode-amplifier combination that achieves a similar result is shown in Fig. 5C. This combination is a deadband circuit followed by a preload circuit. The deadband (V_D) and preload (V_P) are controlled independently. This circuit produces a rounded-off switching characteristic; not abrupt, as with the relay.

Usually, a relay is operated by a voltage (V_K) different than the voltage (V_S) that it switches. In Fig. 5D the relay voltage (V_K) controls the switching of two signal voltages (V_{S1} and V_{S2}). The circuit path for V_{S1} to V_{O1} is "normally open," while that for V_{S2} to V_{O2} is "normally closed."

Simulating such a relay may be advantageous when the proper relay may not be available or convenient to

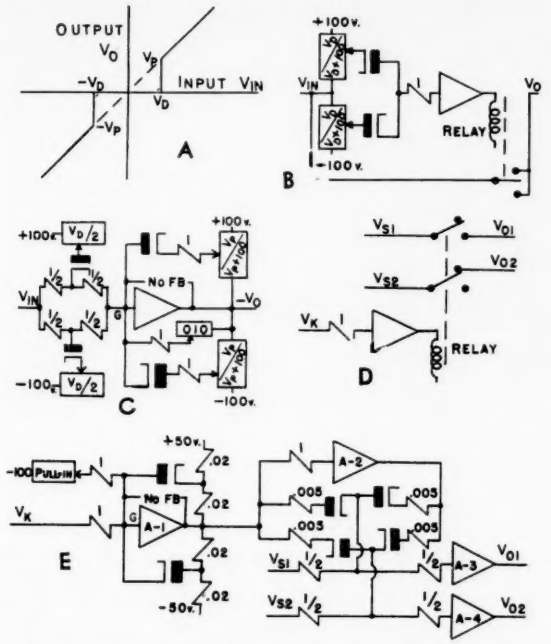

Fig. 5. A is characteristic of a relay switching its operating voltage. B and C are simulation circuits. Arrangement of a more typical relay is shown at D; here signal voltages V_{S1} (normally open) and V_{S2} (normally closed) are separate from operating voltage V_K. Simulation of this relay is shown at E.

use, or when the pull-in/drop-out differential may not be tolerable to the rest of the associated circuitry. This relay simulation is shown in Fig. 5E.

The output of A1 is +50 v when V_K is less than pull-in, and −50 v when V_K exceeds pull-in voltage. Amplifier A2 is a sign-changer. When the output of amplifier A1 is +50 volts ($V_K <$ pull-in), the top two diodes conduct, swamping signal V_{S1} to ground. When the output of A1 is −50 volts ($V_K >$ pull-in), the bottom two diodes conduct, swamping signal V_{S2} to ground.

More circuits that the two illustrated can be switched; a series pair of diodes being required for each circuit switched.

ABSOLUTE VALUE

The absolute value |X| of a quantity X may be generated simply by rectifying (limiting at zero) the −X output of one amplifier and summing this into a second amplifier along with X itself. In terms of voltage, $V_O = |V_{in}|$. Fig. 6A illustrates this characteristic.

With the circuit of Fig. 6B, the output (V_O) will not quite reach zero. This is again due to the transition region of the diode, and may be partially compensated by the "symmetry adjust" pot.

The action, in the neighborhood of zero, can be considerably sharpened with another amplifier. In the circuit of Fig. 6C, the upper amplifier replaces the diode of Fig. 6B. This amplifier has a more abrupt transition than the diode.

FUNCTION GENERATION

Fig. 7A is a linear transfer characteristic except that line slope changes at one point (V_B). The difference in

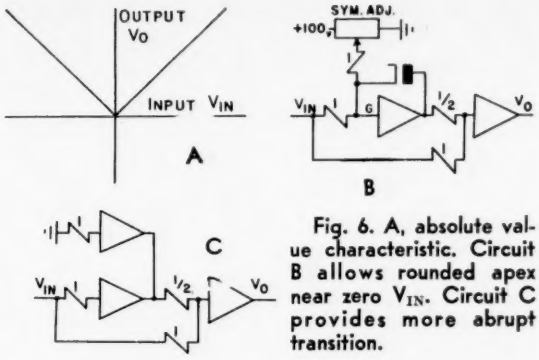

Fig. 6. A, absolute value characteristic. Circuit B allows rounded apex near zero V_{IN}. Circuit C provides more abrupt transition.

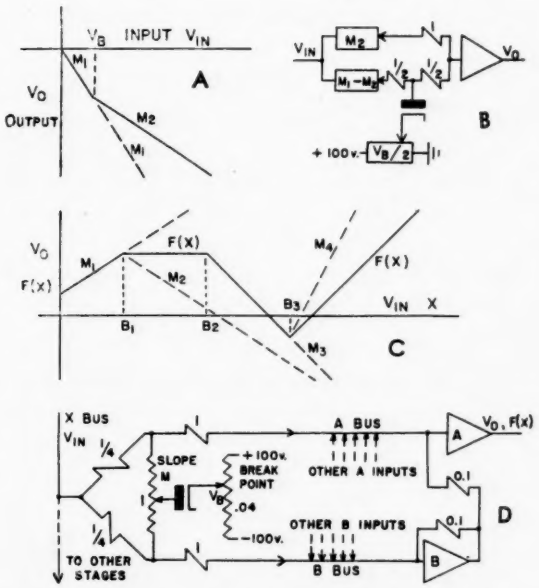

Fig. 7. A, function generation with one change in slope. B, circuit for simulating A. C shows a series of straight lines for approximating a function. D shows a stage that develops one break-point and accompanying straight line; identical stages, linked as indicated, each contribute a break-point and straight line.

the slopes is $M_1 - M_2$. In the circuit of Fig. 7B, consider M_1 as composed of two components, ($M_1 - M_2$) and M_2. From zero input to V_B, both inputs contribute to V_O. When V_{in} exceeds V_B, the diode conducts and holds input $M_1 - M_2$ constant.

This two-segment, straight-line approximation of a function can be extended to a three- or four-line segment approximation by adding other component inputs. Adding more segments and more diodes for more complicated approximations can get a bit unwieldy on an analog computer. This is where the separate-diode function generator enters.

Diode Function Generator

The diode function generator can approximate a reasonably behaved function f(x) by a consecutive series of straight lines (Fig. 7C). "Reasonably" means no position discontinuities, and slopes of approximately

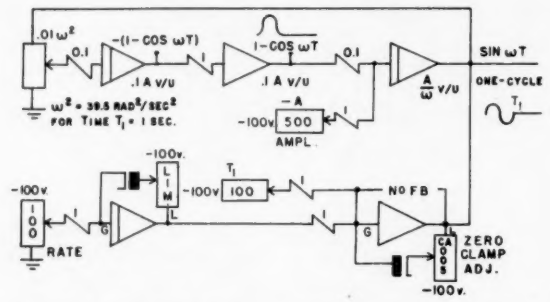

Fig. 8. One-cycle pulse, or gust, is developed by this "Ramirez Gust Generator" circuit. Lower portion of circuit clamps amplifier output at zero after passing one cycle.

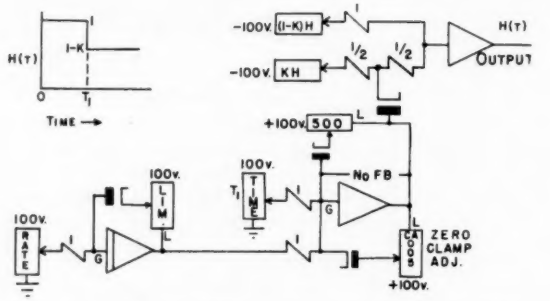

Fig. 9. Circuit providing a step output change after a given time T_1.

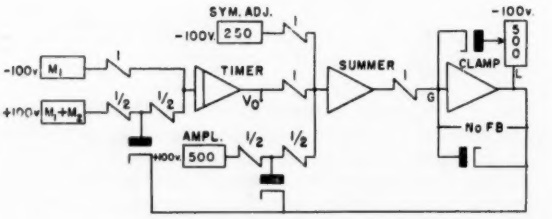

Fig. 10. This circuit uses clamp-amplifier principle to generate triangular wave by special slope combinations.

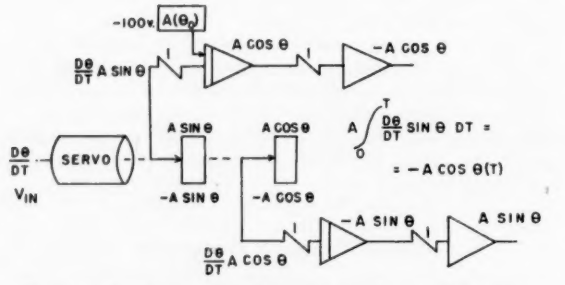

Fig. 11. Continuous resolver can resolve angles greater than ±180°, can also generate tan θ and sec^2 θ between the limits of ±90°.

±45°. Infinite slopes (position discontinuities) or even steep slopes are not suitable for simulation on the diode function generator.

Operation of an 11- or 21-segment diode function generator is explainable by Fig. 7B. Incremental slopes are accepted and added algebraically at each successive break point. Circuit additions are needed, however, to permit other slopes than maximum positive and maximum negative. Fig. 7D illustrates the circuitry of one diode stage. The dotted lines indicate wiring to and from similar stages. When the diode is not conducting, i.e., when the V_{in} signal is less than voltage from the breakpoint pot, amplifier B acts as a sign changer so that equal and opposite voltages are fed into amplifier A.

GUST GENERATOR

There is an occasional need for an accurately controlled pulse or "gust" as an input or forcing function. In such cases, a "one minus cosine" is often used as an approximation, and a one-cycle sine wave as a doublet impulse. Both types of forcing functions are available from the gust generator in Fig. 8.

Any given integral number of cycles can be produced by timing the clamp to shut off the sine output after the desired number of cycles. Clamping does not disturb the initial conditions. To let the oscillator start, the input polarity to the clamp amplifier is made negative. Thus, by periodic clamping, bursts of sin ωt and $1-\cos \omega t$ are possible. The length of a burst and interval between bursts are determined by the clamp input polarity.

TIMED STEP

The circuit in Fig. 9 is useful in providing a step output change after a given time T_1. The timer-integrator and clamp amplifier are similar to that of Fig. 8. Instead of a constant −100 v input signal, the input to the upper amplifier could be a signal that is always negative; in this case, the circuit provides for a step change of K at time T_1.

TRIANGLE WAVE GENERATOR

Fig. 10 illustrates another application of the clamp-amplifier principle. The forward (positive slope) and back (negative slope) times of the triangular-wave generator are controlled arbitrarily by the M_1 and $M_1 + M_2$ slope pots, respectively. The second pot, $M_1 + M_2$, is not independent of the M_1 pot, as it has to cancel the M_1 slope contribution as well as add an M_2 component. The amplitude pot controls the peak-to-peak amplitude. The symmetry-adjust pot is dependent on the amplitude pot setting, but allows the triangular-wave output to be referenced to any average value, such as zero.

CONTINUOUS RESOLVER

Although not employing diodes, the continuous-resolver circuit in Fig. 11 is included because of its similarity to the upper half of the circuit in Fig. 8, and because it will continuously resolve angles greater than ±180° where most servo resolvers are useless. The circuit is basically a sinewave oscillator which has overall loop gain (ω^2) controlled by a servo multiplier in accordance with $d(\omega t)/dt = \omega$. This circuit can be used to generate tan θ and sec^2 θ between the limits of ±90°.

Acknowledgements:

To Ken Tuttle and William Taylor of Northrop Aircraft, Inc., for their comments and assistance in preparing this paper.

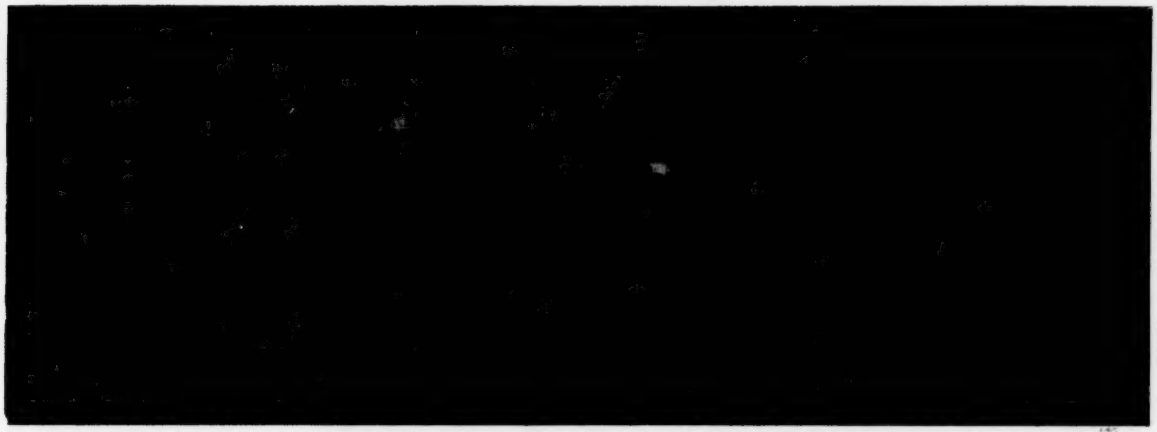

Fig. 1. High-speed (10 readings per second) temperature recording system has stepping switches connected to alternate high- and low-temperature thermocouples.

Recording 10 TC/SEC

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IN these days of high-speed flight and processes, it is necessary to record measurements faster and faster. Typical direct-reading temperature-recording systems use self-balancing strip-chart potentiometers and stepping switches; and operate at a maximum rate of 60 recorded temperatures per minute.

It was decided to approach the problem of obtaining higher recording speeds by using stepping switches to switch thermocouples to a high-speed recorder.

An investigation of available direct-writing, pen-type oscillographs indicated one suited for this specific purpose. The average direct-writing oscillograph has some zero drift on d-c amplification, which is not satisfactory if long-time, unattended operation is required. The Offner "Dynograph" has negligible drift, which permits setting amplifier gain and balance controls to give fixed deflection for a specific range of temperature. The Dynograph sensitivity is such that 1C° change produces a pen deflection of ⅛" (3 mm). Actual ranges of −100°F to +600°F were used (each chart division corresponds to 10F° change), Fig. 1. A calibration showed (as the manufacturer specified) some nonlinearity if the entire width of the record was used. As it was desired to utilize the maximum recording width, a celluloid scale was used to read the temperatures, obviating the need for printing specially calibrated recording paper. Either inkless or ink records can be made satisfactorily, and recording paper speed can be reduced to provide a 1-hour record.

As the direct-writing oscillograph has no cold junction, a common ice bath is used as cold reference. It is also possible to use one of the hot-reference junctions available for this purpose.

At first it was hoped to use stepping switches on self step to record about 30 temperatures a second, but tests showed the upper limit near 10 temperatures a second. Best practice is 7 to 8 temperatures a second, or 48 temperatures in 6 to 7 seconds.

Fig. 1 shows only one channel of the two-channel recorder being used. Both channels would provide 96 temperature measurements in 6 to 7 seconds. This would also permit two different temperature-recording ranges. Tests conducted with Brown double-stepping switch boxes (48 points) show additional switches can be used to make any number of measurements.

It is necessary to provide a stepping voltage for the stepping switches. Although an RC circuit will operate the stepping switches, the "on-off" time is not completely satisfactory. As an alternate to the RC method illustrated in Fig. 2, a slugged relay timer will provide a 50% on-off timing cycle.

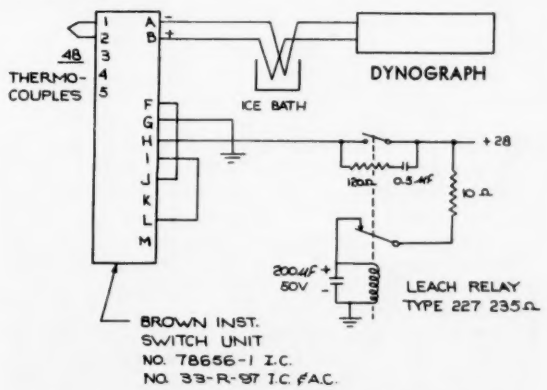

Fig. 2. 48 thermocouples are each read every seven seconds by Dynograph. Stepping switches may be ganged to provide additional channels.

Fig. 3. Equipment used for high-speed recording.

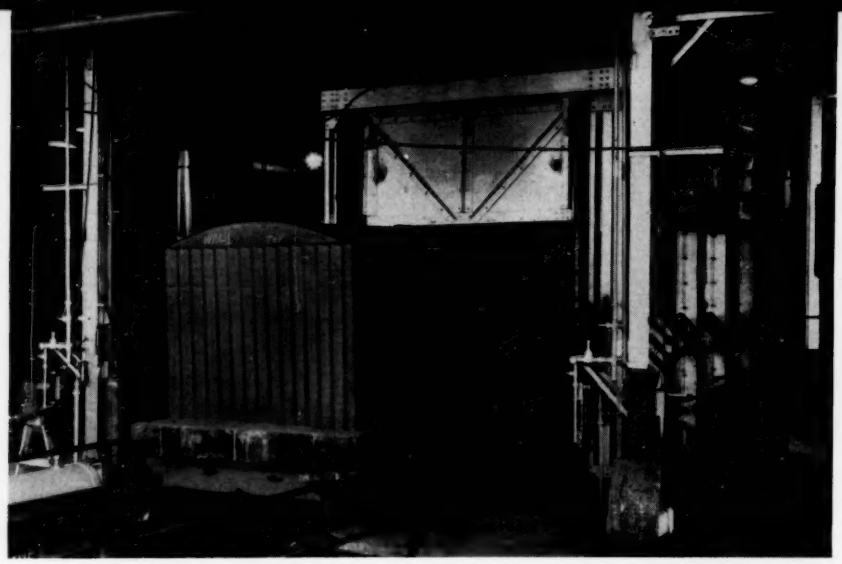

Fig. 1. Tunnel furnace provides continuous batch-type annealing of special-properties plate and sheet charged on movable boxes. New charge is pushed in at cold furnace end while other car is pushed out at exit end when cycle is completed.

Instrumentation of a Continuous

Annealing of steel sheet and plate of softness and extraordinary ductibility has long been performed in batch-type operations adapted from the ceramics industry. A continuous method with improved instrumentation results in 1/3 higher production with 1/2 the BTU input.

RALPH H. GELDER
and
WALTER E. HAND
Armco Steel Corporation
Ashland Works

ASHLAND, Kentucky Works of Armco Steel Corporation have long been known in sheet and plate manufacture for their continuous batch-type annealing furnaces (Fig. 1). Sheets and plates are loaded on insulated car bottoms, and covered with a light plate stainless-steel cover which rests in a sand seal around the outer edge of the car. Atmosphere gas, either DX or natural gas, or a mixture of the two, is charged into the box, which is then pushed into a tunnel-like gas-fired furnace. As a new box enters the furnace, another one is pushed out at the exit end (Fig. 1), then slowly cooled, unloaded and readied for recharging.

Instrumentation

The latest furnace of this type, put in operation about three years ago, adheres to this time-proven principle, but features several constructional improvements, including extensive temperature control. The resulting higher production rate and lower fuel consumption, coupled with less personnel in attendance, reduced overhead crane service required, and greater uniformity of product, have justified expenditures for the instrumentation.

Thermocouples are placed in strategic locations on the charges inside the boxes and in the combustion space between the box cover and the furnace walls. Fig. 3 illustrates the manner in which thermocouples are mounted. The hot junction of a thermocouple is placed in contact with the side face of the pile of sheets or plates, as loaded, within six inches of each top corner of the load. Tests have shown these positions to include the hottest spot in each charge. In addition to four corner thermocouples, one is mounted under the load (as near to its center as piling conditions will permit) to detect the temperature at the coldest position in the box. Leadwires from these thermocouples are conducted through gas-tight seals in the car bottom refractories to a terminal box on the underside of the car. The circuits are completed by means of polarized plugs in the recording and controlling instruments on the panel-board. Sufficient cable is attached to the plug assembly to reach from one box position to the adjacent one. Proper operation of the equipment requires that all plugs be changed to succeeding boxes immediately after each furnace charge is made.

Suitably protected thermocouples, mounted on each side through the furnace walls, detect the temperatures of the centers of the combustion chambers in each zone. Each box position is designated a "zone" for purposes of firing and temperature control.

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh.

Fig. 2. Pairs of 6-point strip chart recorders record temperatures at various points of furnace and work.

Batch-Type Annealing Furnace

Strip-chart recording and controlling pyrometers are installed in a control and meter house which is centrally located with respect to the entire installation of five furnaces. A view of the panelboard is shown in Fig. 2. Each vertically mounted pair of instruments records and controls the temperatures of one box, or zone. The upper instrument records the temperatures in the four corners of the charge in the box; the instrument in the lower position records the temperature of the combustion chambers on each side of the box.

Control of temperatures is accomplished through simultaneous regulation of fuel and combustion air to all the burners on each side of each zone. Control circuits are so arranged that as long as the temperatures of the two thermocouples in the box on one side of the furnace, and the temperature in the respective combustion chamber, are below their set points, fuel will flow at a preset maximum rate. However, when the temperature at any one of these points rises above the set point, the fuel is reduced to a preset minimum. This action is effected by a series arrangement of the control circuits from the three points involved so that interruption of the circuit by any one point will de-energize an electro-pneumatic relay controlling the butterfly valves in the combustion-air line for the burners in the side of the zone. Gas is proportioned by zero governors (regulators that maintain the gas pressure at zero or near-atmospheric pressure). Relief dampers in the furnace roof are actuated in synchronism with the control valves by their own motor operators.

A typical chart, illustrating the uniform temperatures obtained around all four corners of the charge by this type of control, is shown in Fig. 4.

A six-point stript-chart pyrometer records temperatures at the bottom of the box. Fig. 5 shows a typical chart. Flexible circuitry makes possible recording of bottom temperatures of any six of the twelve boxes under fire. Since it is important to consider the temperatures of those boxes which come into the soaking period of the cycle, the temperatures in these and the immediately preceding zones are recorded. Degree of uniformity of the bottom temperatures from box to box is quite clearly shown in Fig. 5.

Extensive changes in annealing temperatures can be made on consecutive boxes with satisfactory results.

Description of Furnace

The furnace has the general shape of a tunnel, with bottom formed by twelve insulated car bottoms, each 16 feet long.

Fig. 3. Thermocouples are fastened to charge at strategic locations, and connected by lead wires to recording controllers on panel board.

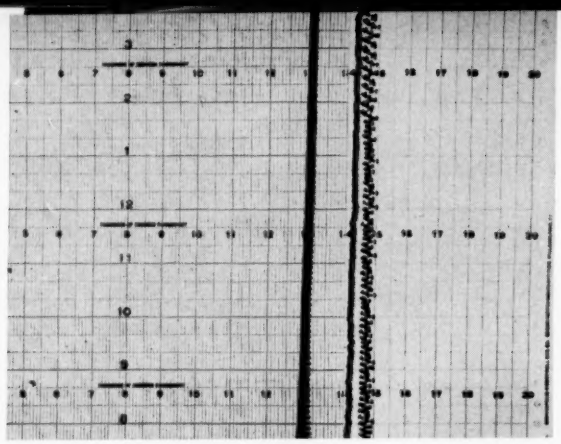

Fig. 4. Uniformity of controlled temperatures is demonstrated by near-vertical lines.

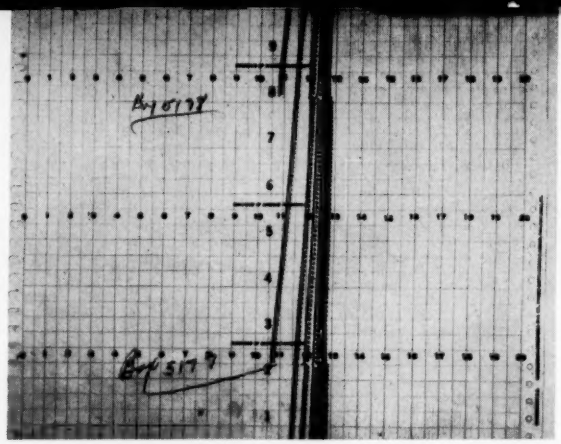

Fig. 5. Temperatures recorded at bottom of box also are controlled.

This type of furnace, adapted from the ceramics industry, was built by Armco Steel Corporation for box annealing the products of the original continuous sheet rolling mill at Ashland, Kentucky, as far back as the middle twenties. Most other producers of flat-rolled steel have adopted the portable bell-type box annealing furnace as successor to the older single-door stationary-fired furnace. Satisfactory experience with these furnaces led to construction of additional two furnaces of the same general characteristics a few years later. They are still in use.

About three years ago, when demand for further increase in box annealing capacity developed, an improved model of this continuous type of furnace was developed, with greater output and reduced heat input requirements. Attainment of these advantages can be attributed to automatic control plus the placement and arrangement of burners, whereby the heat input is concentrated at the bottom of the charges. The burners are distributed along the furnace walls according to the probable distribution of heat demand. Since the first zones serve to provide the major part of the heat required to bring the box charges up to annealing temperature, they are fitted with more and larger burners than the following zones. Fuel is 1000 BTU/cu ft natural gas, and combustion air is furnished by low-pressure blowers at 5 and 7 inches w.c. max pressure (depending on burner location).

Furnace Operating Procedures

At each end of the furnace (which accommodates 12 car bottoms) there is a pit, in which a transfer car or lorry operates at right angles to the direction of travel of the boxes through the furnace. Cars are propelled onto and off from the transfer lorry and through the furnace and parallel cooling lines by pusher mechanisms built into the transfer lorries. Pits or stalls, into which the cars may be pushed by the transfer lorry for loading and unloading, are located along the side of its operating pit opposite the entrance to the furnace. These loading pits are served by an overhead crane.

A car bottom is loaded with the charge to be annealed and covered in one of the several loading pits. The transfer lorry picks up the car and moves it to a point in line with the tracks under the furnace, where it is pushed into the space on the tracks between the transfer pit and the furnace entrance. At that point, the seal between cover and base is filled with sand, and the interior of the box is flushed with the gas used for protective atmosphere. At the proper time the box, thus prepared, is pushed into the position, in the furnace, immediately inside the entrance door. As the furnace, already in operation, is filled with its 12 boxes, each box is moved forward to the position adjacent to the one previously occupied by the box, and the box in the last position is pushed out of the furnace exit door. At this point, the discharged box is picked up by the exit-end transfer lorry and moved to the cooling track.

Slow cooling to ambient temperatures takes place while the loaded boxes recycle down tracks parallel to the furnace to the entrance end transfer lorry, which picks each cooled car up and spots it in a loading pit for repetition of the cycle described.

Conclusions

This furnace, in its two-year period of operation, has amply demonstrated its superiority over the portable bell-type furnace of similar load capacity in a number of particulars. It has yielded a greater production rate at a lower rate of fuel consumption. No failures have been experienced requiring the rejection or reannealing of any portion of the product. Control is precise and reliable enough to give complete confidence in its performance with a minimum of attention from personnel assigned.

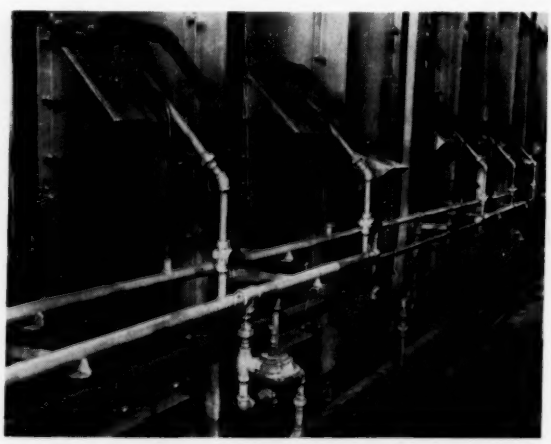

Fig. 6. Burners are arranged at 45° angle from horizontal.

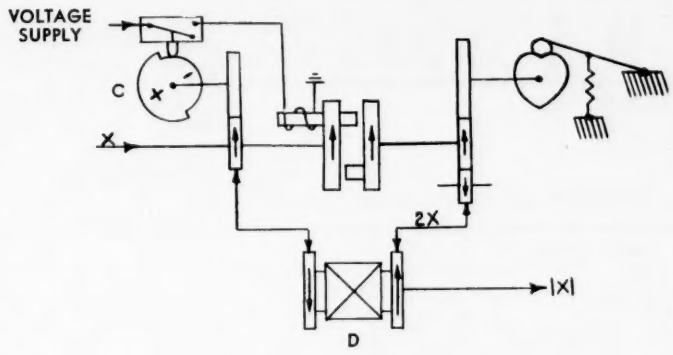

Fig. 1. Absolute-value mechanism comprises differential (D) and solenoid-operated pin controlled by position of cam C.

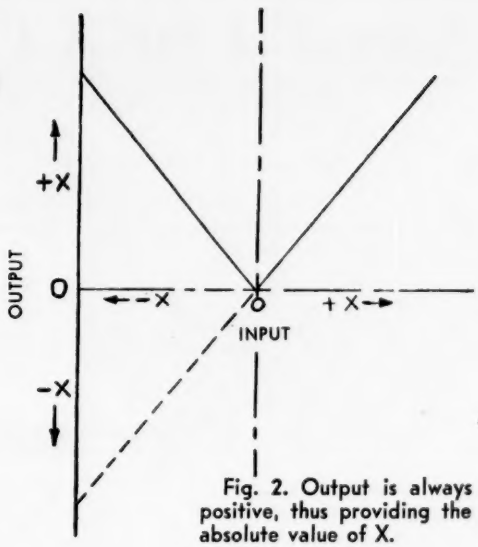

Fig. 2. Output is always positive, thus providing the absolute value of X.

Absolute Value via a Differential

MAX FOGIEL New York, N.Y.

IN the mechanization of equations for automatic computation it is often necessary to obtain the absolute value of a varying quantity—that is, the magnitude independent of its sign or polarity. While this problem is easily solved through the use of an electrical computing circuit, a solution involving mechanical computation is often desirable. This is especially true if both input and output are in mechanical form and inclusion of a servo system is to be avoided.

The mechanical circuit shown in Fig. 1 provides a simple and accurate solution to the problem, using a solenoid-actuated pin and a differential to accomplish the objective.

The principle is simple. The input shaft rotates in proportion to the variable X. This shaft is geared directly to the left side of the differential D, which causes the output shaft to rotate an amount proportional to X also. Hence, an input plus X (counterclockwise) causes an output of plus X. The gearing shown at the upper right in Fig. 1 is not in motion under these conditions.

When the input is negative, however—that is, when X rotates in the clockwise direction—cam C energizes the solenoid which causes the pins to engage in such a manner that the gearing at the upper right of Fig. 1 is engaged. This causes the right side of the differential D to turn an amount proportional to 2X. As the left side of the differential is turning an amount equal to —X, and as the right side now turns an amount equal to 2X, the output is equivalent to plus X. Thus, as the output is always positive and proportional to the magnitude of the input variable, the absolute value of the variable is obtained at the output.

The cam and spring follower serve to retain the fixed pin in firm contact with the sliding pin when X is negative, and is increasing towards zero. The cam-and-follower arrangement also holds the fixed pin in the zero position when X is positive.

The gearing of the cam which operates the switch to the solenoid may be determined in the following manner:

Let the angular displacement of the cam required to operate the switch be represented by δ. Let α represent the angular rotation of the input shaft from the point where the pins break contact to the point where they come into contact again on the other side after nearly one revolution of the input shaft. The gear ratio between the cam and the input shaft is thus α/δ. As only approximately 180° of cam rotation is allowed for the positive region of X, the variable must not exceed the quantity represented by this amount of rotation.

Thus if one revolution of the input shaft represents U units of the variable, X must not exceed $(U/2)$ (α/δ) units. Additional switches may be geared into the circuits, however, if it is necessary to extend the range of variable. In this manner it is possible to obtain any desired computational accuracy.

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Trends in Pipeline Valve Control

Positive control of petroleum liquids and gases is imperative for safety. Complex valve installations are impractical without power operation, remote control, and automatic emergency functions. Lines are controlled commonly by plug valves with rotary-motion actuators, and gate valves with linear-motion actuators.

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POWER OPERATION of oil and gas pipeline valves, on a large scale, is hardly more than 20 years old. Some early installations applied a geared motor drive, which took the place of the conventional handwheel. Today's modern electric valve operators are the result of development of this idea.

About the same time, plug-valve manufacturers offered valves equipped with pneumatic cylinders in place of the conventional handwheel drive gearing.

Fig. 1. Grove-Shafer installation.

These cylinders were primarily intended for air power. In the course of time, high-pressure cylinders became available that used the line gas as power medium.

Until recently no automatic actuation was practiced. Electric operators were controlled by manual push-buttons, cylinder operators by manual 4-way valves. An exception was the automatic line-break control[1] built under the Hedene patents and supplied by the valve manufacturer as part of plug valves.

With the advent of gas-turbine compressor stations, automatic operation of suction, discharge, and blow-down valves became a necessity. Electric control, tied into a cycle timer, answered these control requirements.

Automatic pump stations on crude and products lines became microwave actuated from control points hundreds of miles distant. Electric operators were the logical answer for these modern stations.

Recently much progress has been made in the field of semi-automatic and fully automatic control of both plug and gate type of pipeline valves. Information on the development of these modern operators and controls follows.

Operator Requirements

Operators fulfill their purpose if they actuate (1) positively, (2) within desired time period, (3) effici-

May Meeting: *Thursday, the 16th, Rio Hondo Country Club, Downey, Calif.*
Feature: *C. S. Beard, General Controls Co., will present a paper on "Effective Area of Diaphragm Actuators" and M. Roby, The Fluor Corp., will present a paper on "Instrumentation of a Compressor Plant."*

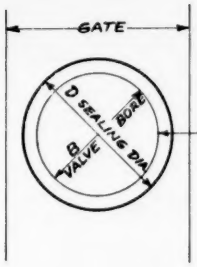

Fig. 2. Gate-valve pressure area.

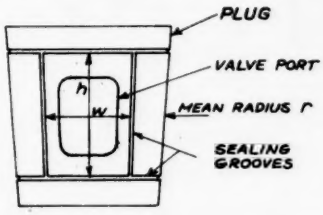

Fig. 3. Plug-valve pressure area.

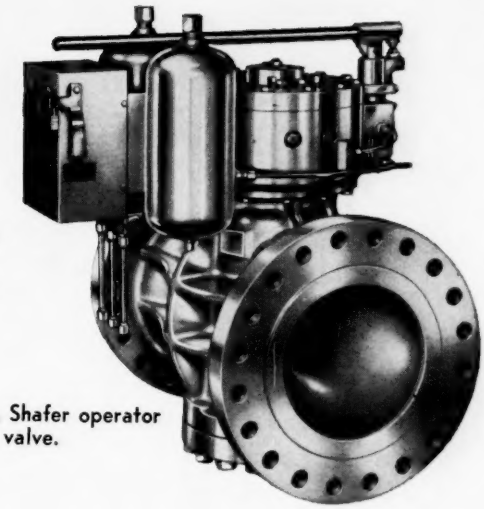

Fig. 4. Shafer operator on plug valve.

ently, (4) through simple, robust controls, and have (5) reasonable space requirements.

The possibility of power failure (either an electrical failure or failure of actuating pressure) requires emergency provisions for manual operation.

Line-Medium Power Source

In recent years, gas pipelines have made use of the pipeline medium as a source of operating power. On electromechanical operators the electric motor is replaced by a gas motor, and electric switches replaced by gas valves. With these modifications, the drive becomes pneumatic-mechanical.

Another major advance consists of the gas-hydraulic operator known in the trade as the Shafer operator. Fig. 1 shows such a modern, large, high-pressure, conduit valve. Gas pressure is led from the line, through control valves, into gas-hydraulic tanks which are partially filled with hydraulic oil. The oil then is of the same pressure as the gas and can be used directly in the hydraulic valve operator.

The resistance of the moving valve member (plug or gate) is approximately proportional to the line pressure. The power available from the line medium is also proportional to the line pressure. We have, therefore, an ideal situation wherein the greater the power required, the more is available. Other means used to convert gas into hydraulic pressure include gas-hydraulic converter-intensifiers.

Manual Operation

If the power fails, valves must be operated manually. Therefore, electro-mechanical and pneumatic-mechanical operators are equipped with an auxiliary mechanical handwheel drive.

Simplest manual operation of hydraulic valve operators uses a small hydraulic pump. Hydraulic manual operation is superior to conventional mechanical drives as it is subject to the same efficiency considerations as power operation. Hydraulic manual operation requires approximately one sixth the energy needed to actuate a valve through conventional mechanical drives; in other words, with equal effort a valve can be closed hydraulically six times faster. This is important for large valves.

The reason that gas pressure is not applied direct instead of through a hydraulic medium is that such systems require a separate device for mechanical *manual* operation which has many disadvantages over the simple hydraulic manual drive. The power device of a hydraulic operator is always in excellent operating condition as it is constantly submerged in oil.

Power Requirements

Gate and conduit valve power requirements are generally calculated as follows (Fig. 2):

$$P = Apf$$

where P= force to move gate (lb), $A = D^2\pi/4$, D = seal dia (inches), p = line pressure (psi), f = coefficient of friction—magnitude depending on condition of the contact surfaces, their roughness and degree of lubrication.

Customary calculations always assume the worst possible condition—no pressure on the downstream side. Also, as a refinement, gland friction and dewedging force (for wedge-type valves) should be added.

Plug-valve power requirements are expressed in torque, as motion is rotary, and calculated as follows (Fig. 3):

$$T = Apfr$$

where T = operating torque (inch-pounds), A = h w (square inches of projected pressure area, enclosed by sealant grooves around port), p = line pressure (psi), f = coefficient of friction between plug and body, r = mean plug radius (inches).

Although plug stem friction torque is usually small, it can rise to a high magnitude under unfavorable circumstances. Therefore it should be added to the plug friction torque.

For fear of generalization, it is dangerous to quote definite coefficients of friction to be applied in the above formulae. However, so as not to omit that vital link we quote these best possible figures for "f": 0.02

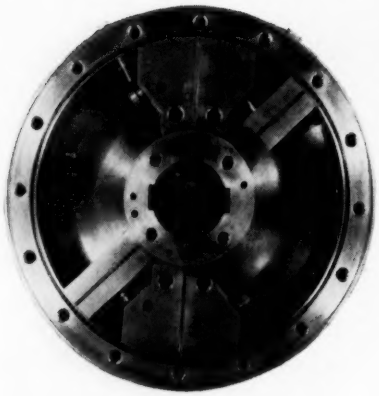

Fig. 5. Shafer operator—internal construction.

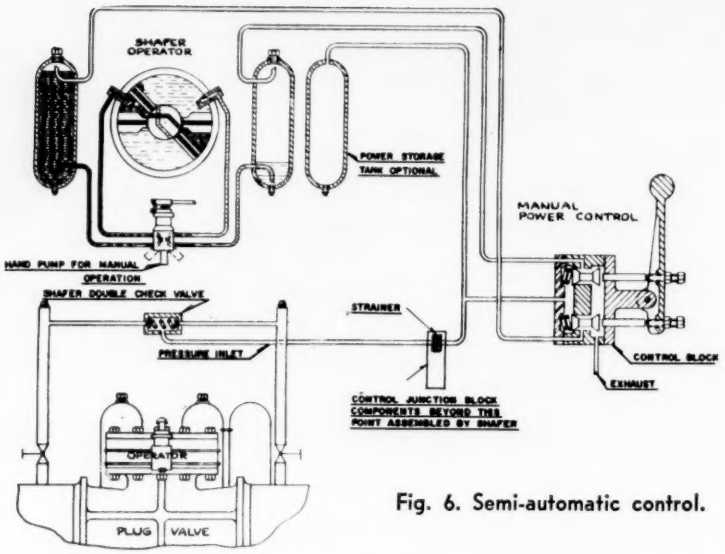

Fig. 6. Semi-automatic control.

on lubricated plug valves, 0.12 on gate and conduit valves.

Operators should be provided with a generous amount of excess power to take into account adverse conditions, neglect, etc.

Gate-and Conduit-Valve Operators

Gate valves, having fundamentally straight-line motion, are logically operated by a piston attached to the valve stem. However, plain piston operators have one serious drawback when applied to wedge-type gate valves. They have approximately the same amount of power in either direction. A gate that is wedged in the end position, open or closed, may be impossible to de-wedge without applying extra power. To meet this condition, cylinder operators can be equipped with a power de-wedging feature. The wedging force is limited by a small relief valve installed in the hydraulic circuit. The main power circuit is shut off before the wedging force is applied and an auxiliary, relief-valve-controlled circuit is introduced for "gentle" but firm wedging action. Positive de-wedging takes place as full hydraulic pressure is applied when reversing direction of motion. A small hydraulic pump, shown in Fig. 6, is provided for manual operation.

Electro-mechanical operators have been applied extensively to gate valves in place of the conventional handwheel. Electric operators are equipped with a hammer-blow device for power de-wedging.

Efficiency is one of the major distinguishing features between electro-mechanical and hydraulic gate-valve operators. The former are handicapped by the inefficient stem screw of the valve, whose efficiency generally runs in the neighborhood of 25%. With the usual 50% efficiency of the mechanical drive of the operator, the overall efficiency of the electro-mechanical gate-valve drive runs around 12½%, not counting electrical losses. In contrast, the efficiency of the hydraulic piston gate-valve drive runs well over 90%.

Plug-Valve Operators

A great many applications demand use of electro-mechanical operators. This type has been described elsewhere in the literature.[2] To keep in step with automation, it will have to undergo an extended development of automatic controls for a variety of purposes.

Since electro-mechanical operators are of the rotary type, they satisfy the logic of applying a rotary operator to the rotary plug valve.

The conventional piston type of operator, which converts straight-line to rotary motion through a gear or lever system, is well known in the pipeline industry. This type is beginning to be displaced, at least in the larger sizes, by the modern rotary Shafer operator or by multi-cylinder operators.

Shafer Rotary Power Operator for Plug Valves

The conventional electric and piston types of operators are well known and need no discussion. However, the newly-developed Shafer operator system does warrant a short description. Fig. 5 shows internal construction of stator and rotor.

Originally the operator was designed primarily for gas pipelines. It takes power from line gas, which, by proper direction, actuates a hydraulic quarter-turn motor attached directly to the plug-valve stem. The conversion from gas to hydraulic pressure takes place in a pair of gas-hydraulic bottles, gas pressure acting upon a hydraulic fluid. If it should ever happen that there is no gas pressure, the operator can be actuated by a manual pump built into the hydraulic circuit—on smaller valves—by a wrench which can be attached directly to the rotor hub.

Power gas is directed, either manually or automatically, to the proper gas-hydraulic bottle by a control

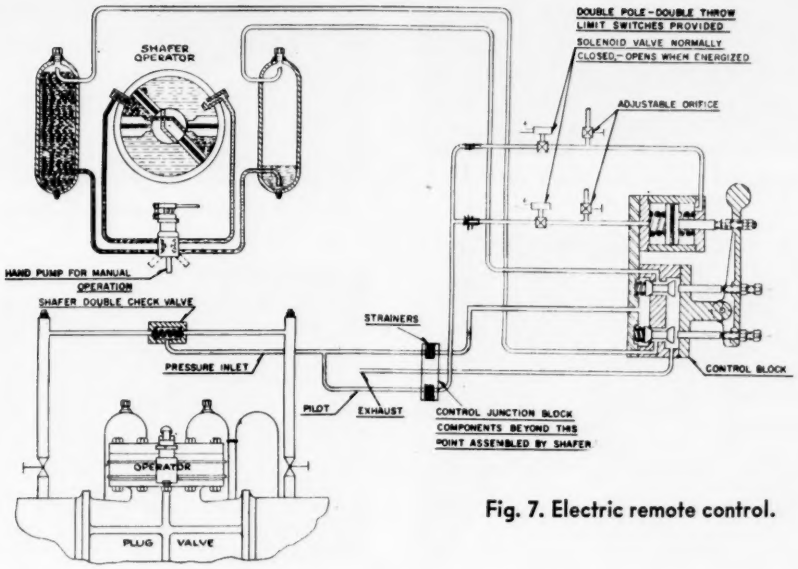

Fig. 7. Electric remote control.

block containing a double 3-way poppet valve, shown in Fig. 6.

The cylindrical rotary operator, connected directly to the valve plug, is the most compact power device yet conceived. The rotary type described here produces the powerful torque of 50 foot-pounds per each cubic inch of displacement at 1000-psi pressure.

This rotary operator has been proposed to the Navy for steering ships. Due to its high power capacity it should be the smallest rudder-actuating device in existence. Operators are now available powerful enough to steer a destroyer or a light cruiser.

Controls

Until recently it remained for users of the operators to design their own controls. Operator builders are now designing controls and considerable progress is being made for the benefit of the industry and, particularly from a standpoint of safety.

Types of Control

Power operators can be equipped with the simplest kind of control. Fig. 6 indicates diagrammatically the inter-relation of valve operator and control. The valve is closed under power by pulling (and opened by pushing) the hand lever at the control block. Control block and lever are common to nearly all controls. Fundamentally, automatic control is accomplished by actuating the lever by some automatic impulse.

Electric Remote Control

Fig. 7 shows electric control actuation by means of solenoid valves. Gas pressure is available to these small valves which may be wired in various ways; for in-

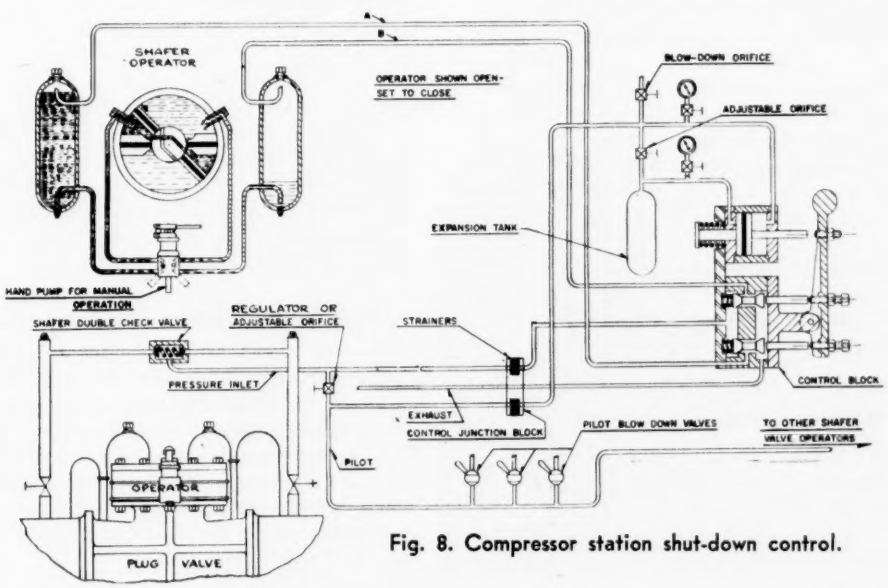

Fig. 8. Compressor station shut-down control.

Fig. 9. Compressor station shut-down control.

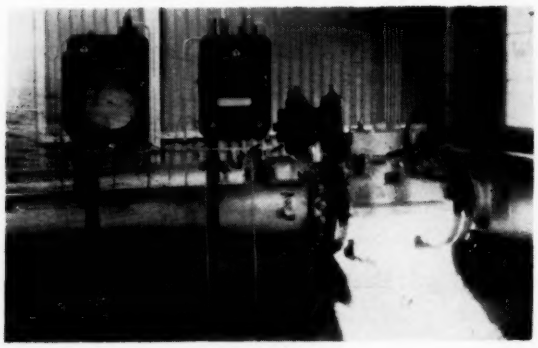

Fig. 10. Meter run.

Fig. 11. Meter run operator.

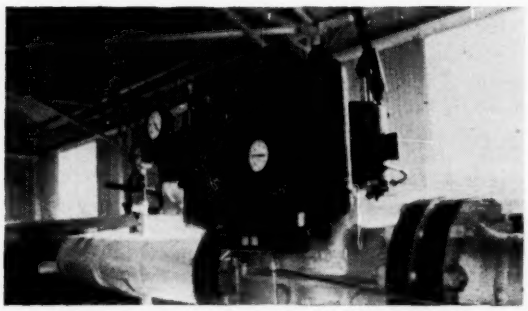

Fig. 12. Blow-off control installation.

stance, they may be wired as indicated or through a time delay for "fail-safe" action, opening when de-energized, in case of current failure. A small pilot piston actuates the control lever.

Compressor Station Shut-Down Control

Compressor station emergency control, as applied to plug as well as conduit valves, is shown in Fig. 9, diagrammatically in Fig. 8. The pilot control piping is charged with 200-psi gas pressure taken from the power gas line through a regulator followed by an orifice. In an emergency, any one of several strategically-located vent valves is tripped; pilot gas contained in an expansion tank actuates the control lever, thus admitting power to the operator. After a preset time the control returns to neutral, relieving the pressure from the operator but leaving the pipeline valve set in emergency position until the control lever is *manually* actuated when the line is returned to normal operation. Returning only the pilot vent valves to normal position has no effect on the operator. The control lever must be actuated manually to re-position the main valve.

In Fig. 9, four valves are closed (to and from the compressor station) and four blow-down valves are opened (the latter after a short artificial time delay) upon tripping any one of the pilot vent valves.

Multiple Meter Run Control

On the dual meter run (Fig. 10) the second run is opened automatically when the metering capacity of the first run is exceeded and closed when the flow is too small for two runs. Automatic action is initiated by a differential controller which, depending on meter orifice differential, supplies either 25 psi or zero pressure to the operator pilot system shown in Fig. 11.

Station Blow-Off Control

A most unusual overpressure protection of a regulator station is shown in Fig. 12 and in diagram (Fig. 13). Instead of a multiplicity of spring-loaded relief valves, a single plug valve is used for relieving excess pressure in the station discharge piping system.

The control can be adjusted readily by means of a small regulator, and blow-off pressure and resetting pressure can be set safely and positively within 2% of each other, if desired.

Plug valves, with their inherently large flow capacity, appear very well suited for relieving excess pressure in piping systems. In dimensioning blow-off valve and piping sizes, the same fundamental rules apply as those pertaining to design of blowdowns for pipelines. Author's earlier paper[3] advises use of the "regular" pattern, rather than the "Venturi" type of valve, as most economical for such purposes. The same paper gives a formula and figures for thrust reaction from issuing gas, which must be taken into account in design of blow-off systems.

Distribution System Emergency Control

The self-contained control (diagram Fig. 14) actuated by a cartridge satisfies the ASA code not only as far as overpressure protection, but also for underpressure protection. It will close upon dangerously high or low pressure and stay closed until manually reset. Damage from explosions and fires in gas distribution systems can be held in check by this small control device which can be installed on existing valves without vault enlargement.

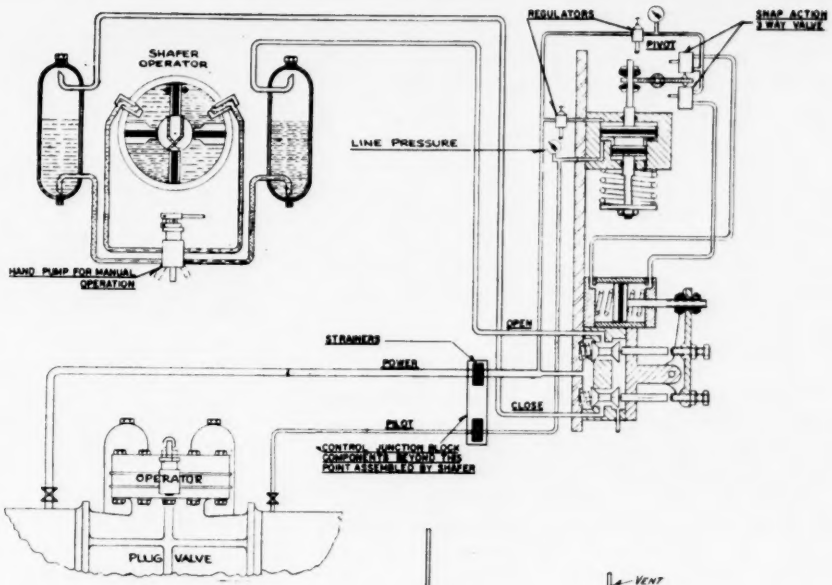

Fig. 13. Blow-off control diagram.

Automatic Line Break Control

An advanced line break control[4] is shown in Fig. 15. As a rule, all valves in the vicinity of a break close when equipped with conventional automatic line break controls. Sometimes a chain reaction may unnecessarily close many valves. The new line break control senses the condition of the line, keeping shut only the two valves on each side of the break and automatically reopening any other valves which may have closed.

Automatic Regulation

Large capacity and low noise level make the plug type of valve a desirable device for regulating gas. Controls now being developed show promise for use of these valves for regulating purposes, particularly in sizes beyond the capacity of conventional regulators, if equipped with modern operators.

Hydraulic operators are excellent devices for regulating services. Hydraulic regulation has been applied to precise turbine regulation for half a century and can be applied directly to pipeline regulation problems. Essential equipment components comprise (1) device sensing abnormal conditions of pressure, flow, etc., (2) pilot control to direct fluid to operator, (3) power operator, (4) feedback device to restore neutral position of pilot.

Gas is not suited for regulation purposes when applied directly to power cylinders. This medium, being elastic, would cause overshooting and hunting due to the varying resistance of the valve.

While plug valves appear to be desirable regulating devices for gas lines, they are unsuitable for liquid lines as liquids under high velocities rapidly wear away flow passages of ordinary materials and also can cause detrimental effects due to cavitation.

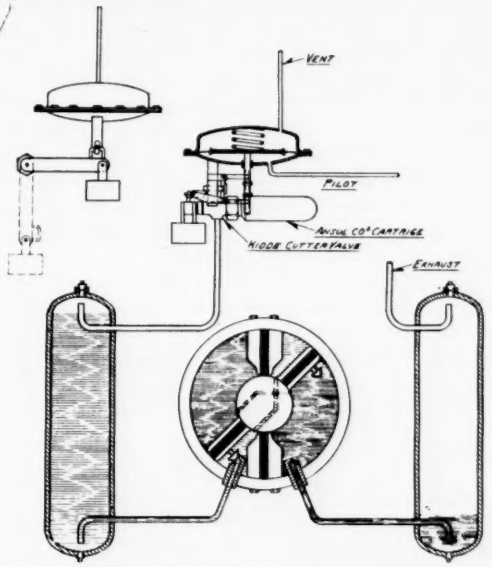

Fig. 14. Distribution system emergency control.

Fig. 15. Automatic line break and reopening control.

General Operator Characteristics

When specifying operators, it is necessary to give size, type, and Figure No. of valve, nature of line fluids, maximum line pressure, mounting position, the function to be performed by operator and controls, pilot pressure for specific controls and ambient temperature (minimum and maximum). The latter is important in selecting proper operating fluid. Hydraulic operators must be operable at the lowest atmospheric temperature encountered and oils which remain fluid under these conditions must be used.

Operator Fluid

Contrary to common belief, ordinary oils attack metals. Therefore, operator fluids must be chosen with care. To protect the highly-finished interior surfaces, and minimize foaming due to abrupt passages, operator oils must contain rust and foam inhibitors. Such oils are available from oil distributors. Ordinary motor oils available at service stations are unsuitable and can do permanent harm to operators.

Using a valve for two purposes by equipping it with another operator simplifies the piping system. For instance, in the case of the dual meter run control, one valve can act both as automatic "on-off" as well as shut-off valve. This feature is particularly welcome in existing lines when the addition of an operator on an existing valve eliminates breaking into the line to install an additional device.

To modernize existing valve installations by providing them with an operator, it is desirable to mount the operator under pressure, without shutting down the line. That feature depends on design of the valve; for instance, the well-known Nordstrom Hypreseal valve permits addition of an operator under pressure.

Maintenance

Modern operators require practically no maintenance as hydraulic oils last as long as mechanical equipment. However, oil level must be checked occasionally and the system refilled, if necessary.

Provisions should exist to vent any gas or air which may be entrapped in the hydraulic system. Experience on turbine governing systems has demonstrated the detrimental effect of entrapped air on the regulating function.

Proper condition of the valve is of greatest importance. Operators can be made powerful enough to handle even a neglected valve. To forestall this possibility of damage, plug valves should be lubricated on a fixed schedule per valve manufacturer's recommendations. Modern lubricant guns are equipped with pressure gage. Lubricant should be injected into the valve until the lube pressure settles at somewhat over line pressure.

Incidental Control Features

It is often necessary to know valve positions at a central control point. Electric limit switches, mounted on the operator, show open or closed position by means of indicating lights.

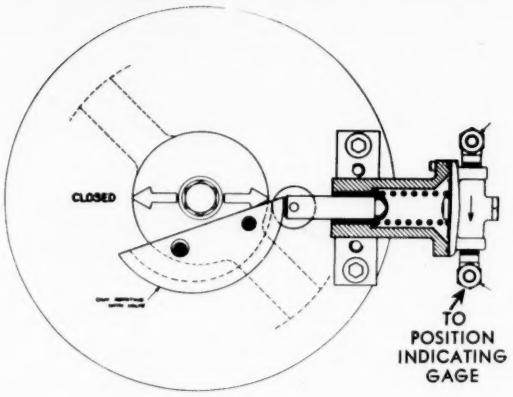

Fig. 16. Pneumatic position indicator.

A continuous pneumatic position indicator mechanism is shown in Fig. 16. A cam, rotating with the valve plug, actuates a modified instrument regulator whose output pressure is led to a pressure gage having a dial graduated in terms of valve position.

ASA Code

The ASA Code (B 31.1.8) for gas transmission and distribution piping is considered the law of the pipeline industry. At the time of its writing all available acceptable devices were included. However, such rapid strides have been made in the field of pipeline control that it was impossible to include important developments of recent years. The code in itself is a token of progress and its spirit does not shut the door to modern engineering developments. Justifiably, some parts of the industry accept new equipment with hesitation when it is not mentioned in the code.

One of the items belonging in the code is the use of plug (and possibly conduit) valves for pressure-relieving systems. It would be appropriate for valve and operator manufacturers to cooperate with the code committee to the effect that recent developments be included in the code.

Acknowledgment

The author is indebted to the Shafer Valve Company, Mansfield, Ohio, for permission to use the figures contained in this paper. Most of the devices shown here are subject to patent protection.

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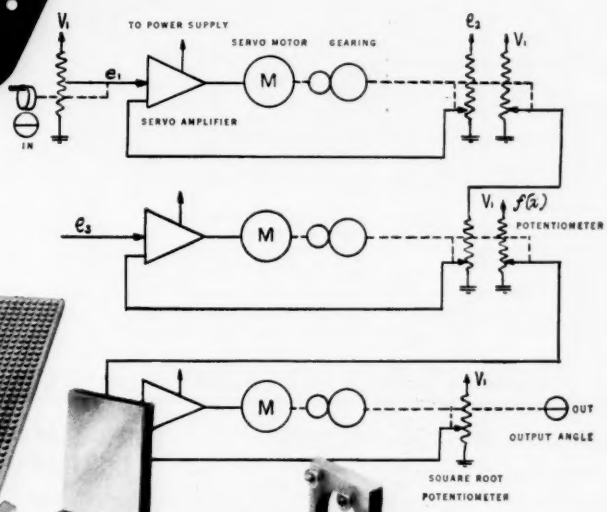
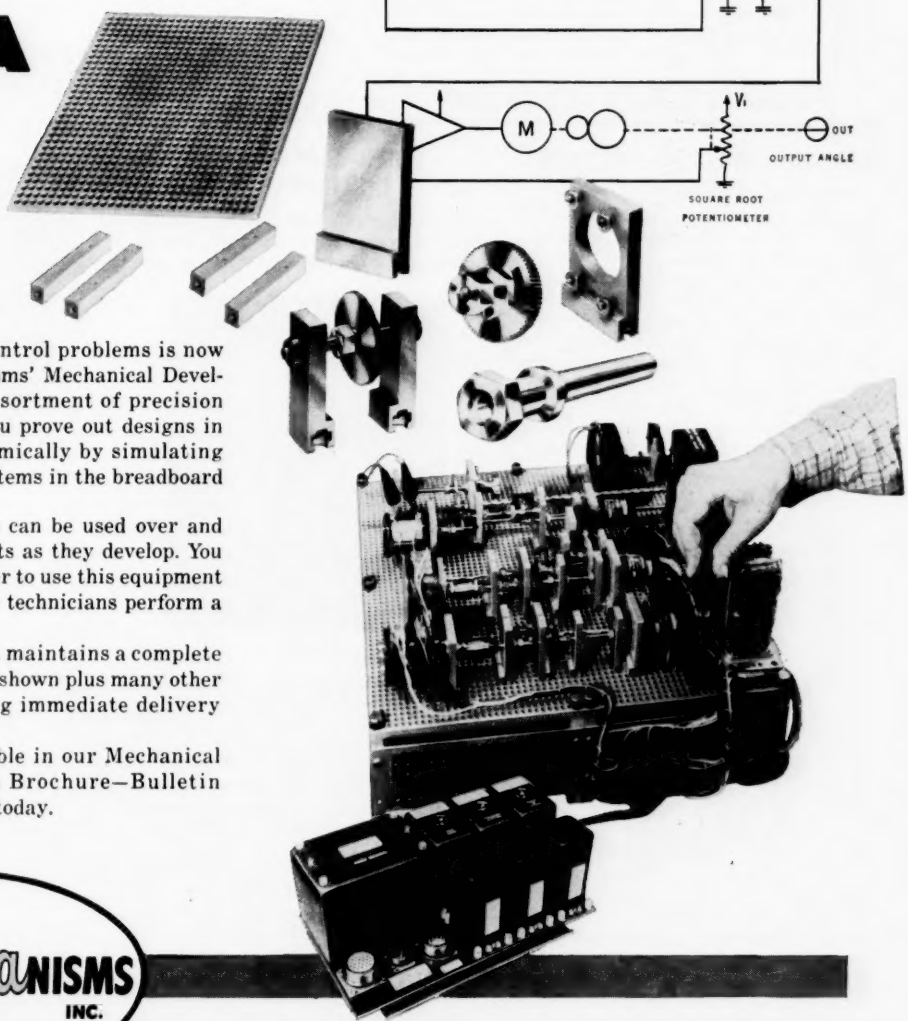
1. Line Break Control, Bulletin V-207, Rockwell Mfg. Co., 400 N. Lexington Ave., Pgh. 8, Pa.
2. Remote Control Electric Valve Operation for Crude and Products Lines, H. A. Altorfer, ASME Paper No. 52PET24, (available from Rockwell Mfg. Co. District Offices).
3. Design of Pipeline Blowdowns, H. A. Altorfer, *Oil & Gas Journal*, Dec. 13, 1954. Reprints available from Rockwell Mfg. Co. District Offices.
4. River Crossing Protection, H. A. Altorfer, *Pipe Line News*, February, 1957.

when you want ANSWERS...

$$\theta_{OUT} = \sqrt{\frac{f(e_2 e_3)}{\theta_{IN}}}$$



you can get them quickly with MDA



Getting the answers to control problems is now easier with Servomechanisms' Mechanical Development Apparatus—an assortment of precision mechanical components. You prove out designs in the lab quickly and economically by simulating instrument and control systems in the breadboard phase.

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For more information circle **74** on inquiry card.

INSTRUMENTS and AUTOMATION

New Instruments

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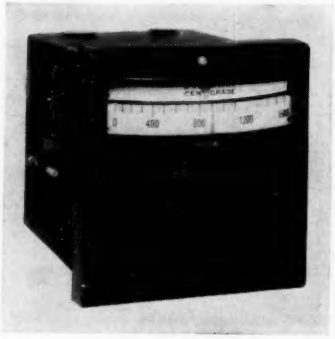
FOR FURTHER INFORMATION USE THE POSTAGE FREE ORDER CARD ON PAGE 789

PROCESS MEASUREMENT and CONTROL

CONTROL MILLIVOLTMETERS

New "HP-30 Series" instruments, designed to keep pace with trend to smaller size in process instrumentation, employ a high-strength magnet material, printed circuits, and miniature tubes and relays. Primarily for temperature control but applicable to process variables such as speed, vacuum, density, and electrical measurables. Electrical connections can be made from front and rear, top or sides. Manual adjustment of one rheostat simultaneously compensates for

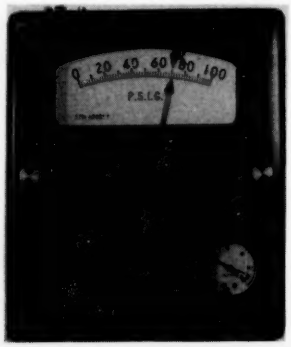


lead length and balances TC break circuit. Range changes can be made in the field. Accuracy 0.5% of instrument span; controller sensitivity better than 0.1% of full scale. "HP-30 Series" comprises two-position controller, three-position dual index controller, three-position single index controller, over-temperature protector, proportional output controller, and time-proportioning controller. These six basic control forms are interchangeable and can be modified. Also available is a millivoltmeter indicator.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **201** on inquiry card.

FIBER-GLASS-CASED INSTRUMENTS

New "Series 1450" low-cost small-size instruments for indicating, transmitting and controlling pressure and

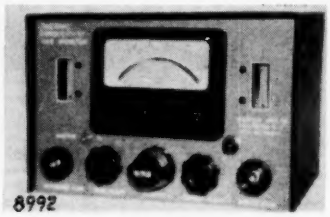


temperature are housed in cases made of plastic-impregnated fiber glass. This case—unique in process instrumentation—makes new line particularly suitable for use outdoors or in corrosive atmosphere. Color is not a surface finish but extends throughout material. Temperature range limits are −400°F and 1000°F; pressures from 30" Hg vacuum to 5,000 psi. As pneumatic receivers, "1450" instruments can accommodate 3-15, 3-18 or 3-27 psi signals. Instruments include single or dual indicators, single indicator with dual alarms, indicating controller with any mode of control, and indicating transmitter. Transmitter can provide pneumatic outputs, resistance outputs, or differential transformer outputs. Controller options include all standard combinations of modes.—*Fischer & Porter Co., 951 Jacksonville Rd., Hatboro, Pa.*

For more information circle **202** on inquiry card.

GAS ANALYZER

New "Thermal Conductivity Gas Analysis Unit," for lab and process gas analysis, portable or panel mount-

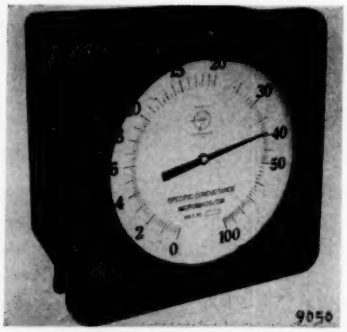


ed, records continuously; can be used for CO_2 stack analysis, argon-nitrogen ratios, trace impurities, etc. Maker also announces new line of fast-response, stable and sensitive cells.—*Westdahl Instrument Co., Millington, N. J.*

For more information circle **203** on inquiry card.

BRIDGE-TYPE CONTROLLER

New "Model RI-3 Self-Balancing Indicating Controlling AC Wheatstone Bridge" is suitable for auto-

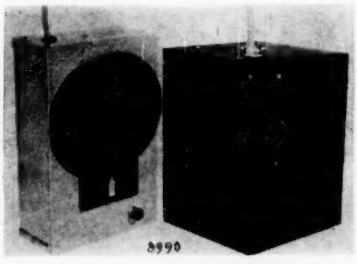


matic control based on measurement of electrolytic conductivity in chemical processing and water treatment fields, monitoring purity of water, etc.; has been recently redesigned and incorporates a printed-circuit amplifier and pluggable units for range changing.—*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J.*

For more information circle **204** on inquiry card.

REMOTE POSITIONER

New "Model AS" is said to be "substantially lower in cost than existing types of automatic control equipment" and to employ "an unusual application of bridge circuitry." It pro-

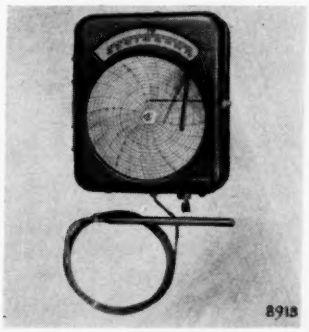


vides positioning accuracy of 0.5% and repeatability of 0.25%, without vacuum tubes or photocells. In addition to valve positioning, etc., it is particularly suitable for automatic selection. In a typical conveyor application it will select shortest route from any position to desired control point by turning control knob to desired "position" number and pressing "start" button.—*Wallson Associates, Ltd., Newark, N. J.*

For more information circle **205** on inquiry card.

INDICATING RECORDERS

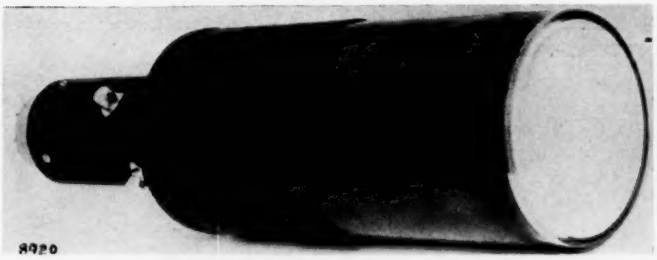
New models of "Minicorder" incorporate a large indicating scale and pointer for easy reading of temperature pressure, electrical values, etc., from a distance. Pointer is fluorescent.



New recorders can be supplied for most of the hundreds of chart ranges now available for "Minicorder design 1 and design 2." Temperature range limits are −200°F and 1000°F; pressure ranges to 2,000 psig; synchronous electric or spring wound clocks; various speeds. Completely sealed against dust, moisture and weather; wall or panel mounting. —*The Dickson Co., 7422 Woodlawn Ave., Chicago 19, Ill.*

For more information circle **206** on inquiry card.

ULTRAFAST-WRITING CRT, revealed at IRE Show, writes faster than speed of light.

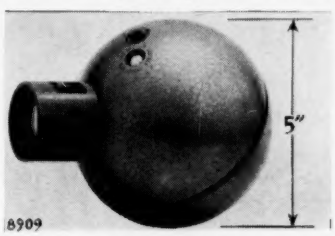


New "K 1419" cathode-ray tube is capable of spot velocity ("writing rate") faster than speed of light across its 5" screen. It does not violate Einstein's velocity-limit principle, for its electron beam can be likened to a garden-hose stream: when nozzle is swung suddenly, stream seems to bend and rate of "writing" on lawn can be much greater than velocity of water at nozzle. Since high spot velocity requires high spot intensity, electron gun and accelerating voltages are exceptionally high. Focus and deflection are both electrostatic. To further assure good photography, No. 11 phosphor is used. Three apertures in phosphor allow light from a built-in source to be transmitted from back of tube to record calibration or reference points on film. An integral Mu-Metal shield minimizes need for special accessory design and orders. Under typical operating conditions, maximum post-accelerator current is 112.5 microamps dc and focusing electrode voltage is 2,000 to 3,200. Grid No. 1 voltage is −75 to −125.—*Allen B. Du Mont Labs., Inc., 2 Main Ave., Passaic, N. J.*

For more information circle **208** on inquiry card.

PHOTOELECTRIC CONTROL

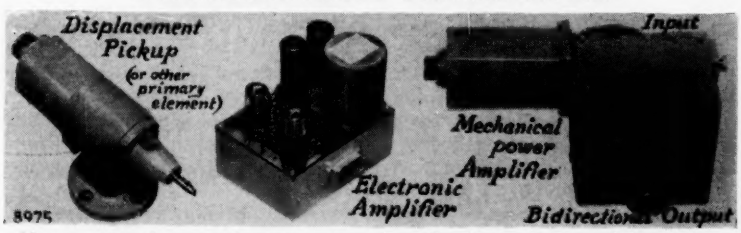
New photoelectric system for counting or controlling comprises light source unit and receiver unit both housed in 5" spheres. Relay in receiver is non-magnetic electrostrictive ceramic actuated unit known as "Capaswitch" (made by Mullenbach Div. of Electric Machinery Mfg. Co.). All operating components of receiver sphere are assembled in top half, which is removable and plugs in to facilitate servicing. Unique easily-adjusted lens system permits focusing



both receiver and projector to allow a small object to break light beam a few inches or a few feet away.—*Basa Controls Co., 4350 S. Sepulveda Blvd., Culver City, Calif.*

For more information circle **209** on inquiry card.

ELECTROMECHANICAL CONTROL SYSTEM



New automatic control system for machines and processes comprises: (1) A displacement pickup sensitive to 0.0003", supplying a linear 60-cps electrical signal of 4 mv per 0.001", and having switches for sensing both initial actuation and overtravel of stylus; (2) an electronic amplifier providing power to a standard 60-cps 2-phase servomotor-tachometer from stylus signal, with tachometer feedback adjustment for system damping control, and test switch for rapid "in place" check of amplifiers; (3) a mechanical power amplifier providing up to 1 hp of control output, taking its power from a contantly-revolving shaft (reference) and, with closed-loop installation, constantly striving to reduce sensing signal to zero. If desired, displacement pickup can be replaced by any standard ac signal source device: process control primary elements, computer systems, etc.—*Seneca Falls Machine Co., Seneca Falls, N. Y.*

For more information circle **207** on inquiry card.

CONDUCTIVITY CELL

New type of non-clogging flow-through solution conductivity cell is of rugged construction with plastic body and threaded metal pipe ends. Electrodes are flush with the bore of the cell, thereby eliminating protruding members that might collect solids and clog up. Available in a wide range of cell constants, and with or without automatic temperature compensation.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **210** on inquiry card.

Only the men are flying

The fact is, men beat birds at their own game. Even when our feathered friends are grounded, we're aloft; flying ever higher, faster, safer, further. And, unbelievable as it may seem, more accurately.

Among the companies spearheading man's conquest of the sky are nine of the GPE Group. Their contributions are basic—technological bench marks such as—

• the only compass systems that *always* know where north is, whatever the plane does, wherever it goes: Kearfott's stable-platform gyro compasses;

• the only simulators to meet the need for on-the-ground training in supersonic flight: famous Link jet simulators;

• the only airborne navigation systems in operational use guiding planes automatically and with unprecedented accuracy – anywhere, in any weather: GPL Doppler autonavigators.

Inertial navigation, missile guidance, photoscience, and certain nuclear power applications, are some other phases of aviation in which GPE companies are deeply and jointly involved. And while many of the products of the GPE companies – particularly in the field of aviation—serve defense needs today, the important scientific advances they embody are "plowshares" for tomorrow.

Aviation is but one industry in which GPE companies work. A brochure describing the activities of the group is available. More than a dozen basic industries are served by products resulting from GPE coordinated technologies and resources.

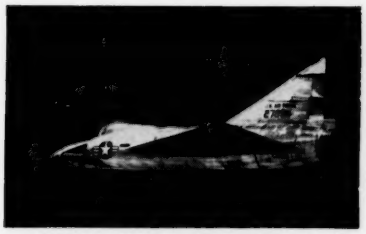
GENERAL PRECISION EQUIPMENT GPE CORPORATION

PRINCIPAL PRODUCING COMPANIES • Askania Regulator • GPL • Graflex • Griscom-Russell
Hertner Electric • Kearfott • Librascope • Link Aviation • Pleasantville Instrument • Precision Technology • Shand and Jurs • Simplex Equipment • Strong Electric

For more information circle **75** on inquiry card.

man aloft

The pilot – before he set eyes on this jet, before he set hand to the actual controls – had already "flown" it. He learned how, on the ground, in a Link F-102 Simulator . . . one of more than a million fliers who have logged "Link time." Millions more will.



Military flight and fliers benefit immeasurably from the systems and equipments developed by GPL, Kearfott, Librascope and the other GPE companies working in aviation. Once these classified products are released for civilian use, everyone will enjoy their benefits.

The coordinated resources of the companies of the GPE Group, so effective in anticipating and meeting the needs of flight, serve with equal effectiveness other industries such as:

Automatic Controls and Instrumentation
Chemical and Petroleum
Marine
Motion Picture and Television
Paper, Printing and Textile
Power Generation and Conversion
Steel, Mining, Transportation

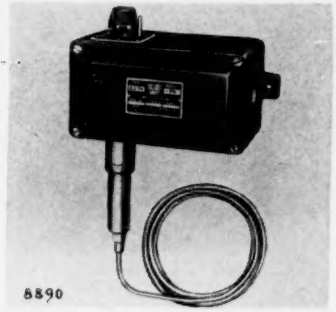
For brochure describing the work of the GPE Group, write to: GENERAL PRECISION EQUIPMENT CORPORATION, 92 Gold Street, New York 38, New York.

For more information circle **75** on inquiry card.

TEMPERATURE

TEMPERATURE CONTROLLER

New "Type E27A" remote-bulb temperature controller contains two switches and often can be used in



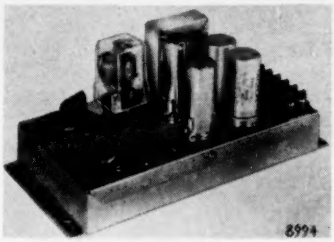
place of two separate single-switch controls. Control head has calibrated setting scale. Models are available with ranges of 100 F° or 200 F° between limits of −150°F and 650°F. Each switch can be adjusted to a maximum span of about 15 F° between switch settings.—*United Electric Controls Co., 79 School St., Watertown, Mass.*

For more information circle **211** on inquiry card.

TEMPERATURE CONTROLLER

New "Model 63" high-sensitivity thermistor-operated unit temperature controller features differential of 0.1F° for all ranges, small size, "easy installation, simple maintenance, ease of adjustment and exceptionally low cost," is available in temperature ranges between limits of −100°F and 500°F; can be grouped in standard conduit boxes for multiple control applications. Power supply is self-contained in each unit. Wide variety of thermistor probes includes over ten types, from $\frac{1}{16}$" stainless steel tubular spring-loaded units to hypodermic needles; suitable for gases, liquids, and solids.—*Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio.*

For more information circle **212** on inquiry card.



INDICATING THERMAL SWITCH

New "Model HL 15-10 High-temperature Limit Control" employs a mercury-filled system; cuts off heat

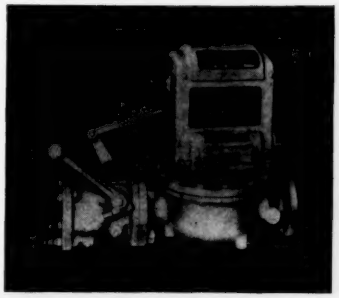
supply if set-point temperature is exceeded. Snap acting switch is of manual reset type. A second switch, in series with control switch, normally is closed; will open only if the temperature should drop to a point below lowest expected ambient temperature (factory preset at 50°F, can be easily adjusted).—*Partlow Corp., New Hartford, N. Y.*

For more information circle **213** on inquiry card.

FLOW-RATE, VOLUME, LEVEL

BATCHING METER

New "Repeating Auto-Stop" liquid batching meter delivers the same quantity of liquid each time its valve is opened, shutting off automatically when preset quantity is reached.



Quantity setting is changed by simply pressing "Auto-Stop" buttons on register. Available sizes: 1", 1½", 2" and 3". Registers available separately for conversion of maker's existing meters: with "Auto-Switch" feature for controlling pumps, agitators, etc., and with maker's "Print-O-Meter" ticket-printing unit.—*Neptune Meter Co., 19 West 50th St., New York 20, N. Y.*

For more information circle **214** on inquiry card.

SMALL-VOLUME FEEDER

New "Model 19130" wall-mounted diaphragm feeder for handling concentrated chemicals directly from shipping containers (for greater safety) offers improved operating effi-

tiny camera sees some shocking sights

THE CLOSED-CIRCUIT TV CAMERA shown above is the world's toughest. Its name: the RUGGEDIZED. The maker: GPL.

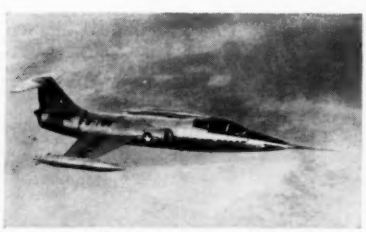
The extraordinary feature of the Ruggedized is its unique ability to withstand shock, noise and vibration. Because of this ability, businessmen and engineers are now able to get clear picture reports on many industrial operations never before seen.

In many instances, the barrier to sight has been vibration too intense or noise too loud for any human (or TV camera) to get close to. Rocket and jet test-stand operations —where the Ruggedized is now being used extensively—are examples.

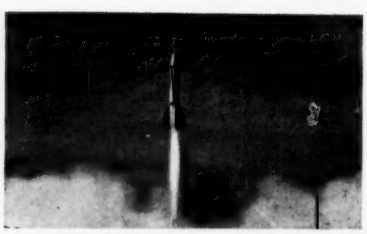
In other cases, inaccessibility has been a complicating factor. To overcome this difficulty, the Ruggedized was made tiny as well as tough.

GPL's Ruggedized camera can withstand temperatures of minus 55°C to plus 60°C, humidity levels of 100%, and is spray-proof. Forces exceeding 15 G's in each of its three axes, noise levels as high as 200 decibels and altitudes over 70,000 feet do not affect its picture detail.

If you'd like to look into your own industrial operations — including those industrial operations you never thought see-able—get in touch with us for full information. If you wish, we will be glad to arrange for a demonstration of the Ruggedized, or any other GPL closed-circuit TV equipment, in your own office or plant by local GPL representative. Write, on your letterhead, to: Mr. N. M. Marshall, General Precision Laboratory Incorporated, 62 Bedford Road, Pleasantville, N. Y.



A spectacular instance of the ability of the Ruggedized to get into – and send pictures *out* of—tight places is its performance *inside* the plenum chamber of an F-104.

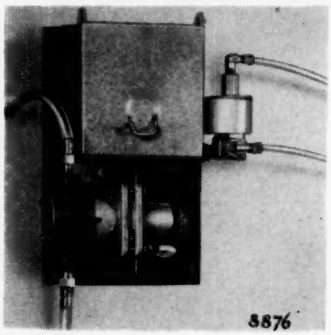


Even bone-shattering concussions can't disturb perfect pictures of GPL's Ruggedized camera, designed specifically for the most severe applications.

GPL
A SUBSIDIARY OF GPE

General Precision Laboratory Incorporated

For more information circle **76** on inquiry card.

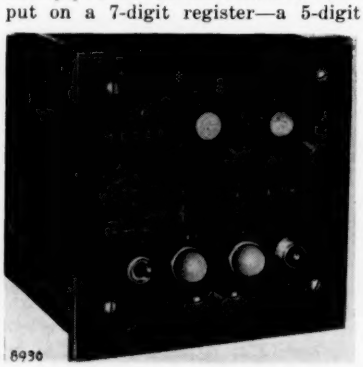


shipping containers (for greater safety) offers improved operating efficiencies, saves manpower, minimizes capital expenditures (initial cost 1/3 that of most similar units), can be installed in minutes by unskilled labor. Pumping rates 0.8 to 8.0 gal per 24-hr period, adjustable by varying stroke length and stroking frequencies.—*Proportioneers, Inc.*, 345 *Harris Ave., Providence, R. I.*

For more information circle **215** on inquiry card.

DIGITAL TOTALIZER

New digital flow totalizer continuously presents turbine flowmeter output on a 7-digit register—a 5-digit



mechanical counter plus a 2-digit electronic counter—showing total pulses, counts or cycles. Indicated count, multiplied by a constant, equals total flow in desired units. System accuracy, when totalizer is used with F&P turbine meter, is 0.5% of indicated total. ★In addition to signals from turbine meters, new unit can accept balanced 500-ohm inputs from any similar signal sources. Power requirements are nominally 50 watts (115 v 60 cps). Size about 6" x 6" x 14" deep; weight 15 lb.—*Fischer & Porter Co.*, 952 *Jacksonville Rd., Hatboro, Pa.*

For more information circle **216** on inquiry card.

LIQUID LEVEL SWITCH

New liquid level switch utilizing radioactive material in sensing element will perform reliably and accurately under extremes of temperature, vibration and shock as well as with most missile fuels; is said to be "smaller, lighter, and more durable

Askania Regulator Company NEWS

Automatic Controls for Edge Position and Thickness, Flow, Pressure, Ratio and Combustion

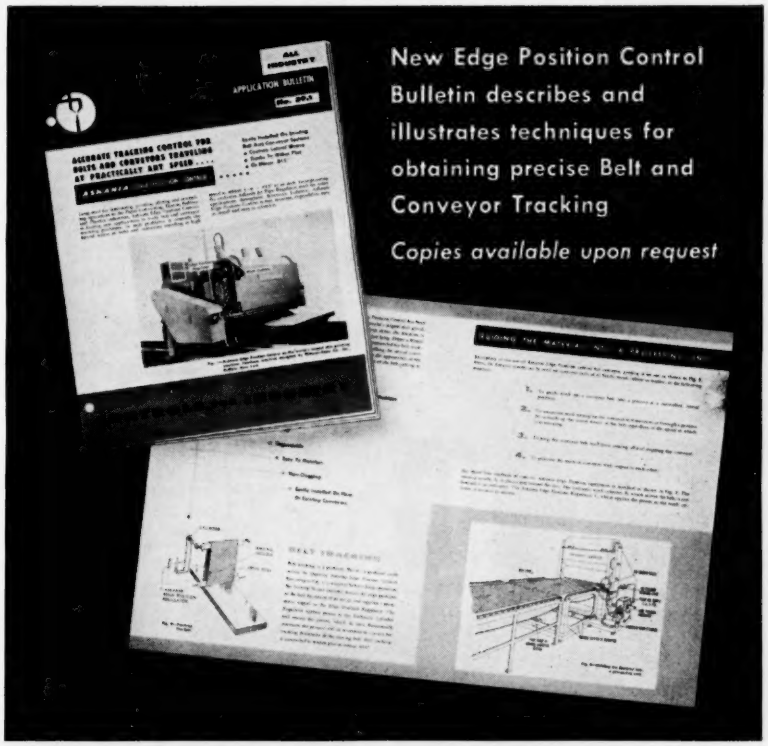
Bothered by LATERAL WEAVE of your Belts and Conveyors?

New information on Belt and Conveyor Tracking is provided in ASKANIA Regulator Application Bulletin #39.1. This bulletin is now available to anyone interested in:

1. **How to automatically control edge position when:**
   - A. Carrying material into a processing unit by means of a conveyor belt so as to deliver it at a specific lateral position into the unit.
   - B. Lateral weave of belt or conveyor must be eliminated so as to keep the material that it is carrying from falling off.
   - C. Tracking is a problem.
   - D. Lateral weave of belt or conveyor must be eliminated to permit maximum speed of operation...and/or prevent the belt itself from working off the roller.
2. **How to guide belt or conveyor at intermediate points or at other positions.**
3. WHAT makes the ASKANIA EDGE POSITION CONTROL the most effective device for eliminating lateral weave of even the highest speed belts and conveyors; easy to install and maintain; readily applicable to practically any belt or conveyor.

For example, the new bulletin diagrammatically illustrates:

- How to obtain precise tracking of high speed belts
- How to guide material into a processing unit
- How to position an intermediate steering roller to guide the belt in process


APPLICATION BULLETIN
New Edge Position Control Bulletin describes and illustrates techniques for obtaining precise Belt and Conveyor Tracking
Copies available upon request

Sound, Practical Operation

Just check the Askania Edge Control advantages, listed below, which are completely described in bulletin No. 39.1. They explain why Askania Edge Position Controls provide consistently accurate belt tracking with a minimum of installation and maintenance. Askania Edge Position Controls are:

1. Non-contact—won't damage the edge of the belt or conveyor
2. Amazingly easy to install
3. Easily adaptable to *new* or *existing* machinery
4. Powerful—can position the heaviest rollers
5. Always dependable
6. Almost maintenance-free

Economy—Versatility

Bulletin No. 39.1 points out why and how these edge position controls

- Save you time and money
- Eliminate trial and error
- Permits higher operating speeds

Answers your questions

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For more information circle **77** on inquiry card.

GYROS
for every application

Kearfott Free, Vertical, Rate, Directional and Floated Rate Integrating Gyros and Stable Elements are accurate, rugged and dependable. They are designed to meet the most stringent aircraft and missile requirements. The Kearfott Free Gyro shown was designed specifically for missile applications. It provides airframe attitude information for use in guidance systems. Remote electro-mechanical caging and uncaging is provided.

ACCURATE RUGGED DEPENDABLE

Kearfott Free Gyros withstand 60 G shock of .0157 secs. duration, vibration up to 500 CPS at 10 G acceleration. Operating temperature range -20° C to +100° C. Weight 5.5 lbs.

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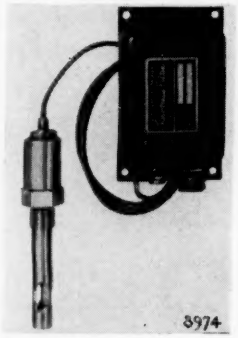
For more information circle **78** on inquiry card.

NEW INSTRUMENTS

than any similar device." Its pencil-size probe contains a hermetically-sealed beta source and a beta detector G-M tube), separated by a small cavity into which liquid can flow. With no liquid present, betas pass



from source to detector; when liquid enters cavity, it reduces radiation level at detector. Change in radiation is converted to an electrical signal. Switch operates on 28 vdc 50 ma. Dp-dt relay will switch a 2-amp load. Accuracy is 0.1", whether liquid is rising or falling. Device operates under vibration and shock of 15 *G* up to 2,000 cps and ambient temperatures from −10°F to 125°F.—*Aero Div., Robertshaw-Fulton, Anaheim, Calif.*

For more information circle **217** on inquiry card.

PRESSURE

PLUG-IN PRESSURE-MEASURING SYSTEM

New "DG-500" model of "Dynagage" is a specially-developed "plug-in" unit for "530-540 Series" Tek-

tronix oscilloscopes; can be used with a complete set of pressure pickups, microphones, flow meters, displacement and proximity pickups, covering pressure range from 0.1 psig full scale to 75,000 psig, with frequency response from 0 to 15,000 cps, and special water-cooled units for use at temperatures up to 6000°F.—*Photocon Research Products, 421 N. Altadena Drive, Pasadena, California.*

For more information circle **218** on inquiry card.

TINY PRESSURE SWITCH

New "GPI-2000" mounts through wall of a pressurized vessel; is grounded and circuit is completed

through pigtail; will adequately make and break up to 0.25 amp, 6 or 8 vdc, resistive load, withstands shocks encountered in missile and aircraft applications. Available in ranges from 50 to 500 psi, (burst pressures to 1000 psi).—*Aircraft Controls Co. Div., Gorn Electric Co., Inc., Stamford, Conn.*

For more information circle **219** on inquiry card.

BAROMETRIC PICKUP

New "Celab Vacuum Cell" senses atmospheric pressure changes by means of a sealed metal bellows acting upon a "Celab Load Cell" whose resistance is thereby changed. With

a power rating of one watt, device operates directly into an ohmmeter, or as a function of a circuit without amplification. Preloading adjustment makes initial resistance values match a circuit parameter. Size: ½" dia by 1½" over-all; total weight 22 grams. Various mounting methods and electrical connections.—*Clark Electronic Labs., Box* 165, *Palm Springs, Calif.*

For more information circle **220** on inquiry card.

TINY PRESSURE PICKUP

New low-volume high-output variable-resistance type pressure pickup, for locations formerly inaccessible, adds less than 0.004 cubic inch to volume of system under test; can be used with liquids and gases; has excellent temperature stability from -65°F to 250°F and holds calibration under long exposure to severe pressure transients. Full-scale pressure ranges are available from 1000 to 5000 psi with full output signals greater than 0.1v.—*Standard Controls, Inc.*, 1130 *Poplar Pl., Seattle* 44, *Wash.*

For more information circle **221** on inquiry card.

LOAD, FORCE, ACCELERATION, VIBRATION

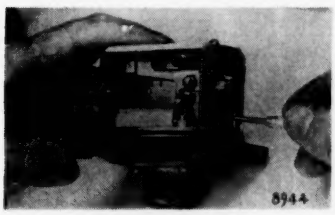
ACCELERATION PICKUPS

The New "11000 Series" features a standard 2½-v or 10-v output with a 26-v 400-cps input. Null voltages are less than 10 mv for 2½v output. Linearity is better than 0.5% and hysteresis less than 0.25%. Thersholds lower than 0.001% can be achieved. Units have been designed to surpass all phases of MIL specs.—*Technology Instrument Corporation*, 531 *Main St., Acton, Mass.*

For more information circle **222** on inquiry card.

ACCELERATION PICKUP

New "Series LA 07-0101-1" features a caging mechanism that prevents resistor wear when pickup is



not in use and protects it from abuse of shipping and handling, but is electrically released when in use. Weight 18 oz; case height 2.56"; dia 3.25" at top, 3.36" at bottom. Operating temperature range −50°C to 100°C; shock-resistant to 40 *G* (to 100 *G* on request). Typical ranges are −1 to +4 *G*, ±5 *G*, ±10 *G;* linearity 0.5 to 1.0%; hysteresis 0.1 to 0.2%.—*Humphrey Inc.*, 2805 *Cannon St., San Diego* 6, *Calif.*

For more information circle **223** on inquiry card.

ACCELERATION PICKUP

New "Model 2216 Accelerometer" weighs 8 grams, mounts within a ⅜" hole; permits accurate vibration measurements to 10,000 cps to be made by mounting it within device being tested. Sensitivity 5 mv per *G;* natural frequency 50,000 cps; temperature characteristics flat (10%) from −30°F to 230°F. Supplied with adapters for surface mounting on vibration tables or devices being tested, and a matching ⅜" tap for mounting within a device under test.—*Endevco Corp.*, 161 *E. California St., Pasadena, Calif.*

For more information circle **224** on inquiry card.

ACCELERATION PICKUP

New improved version of "Model DDL Accelerometers," for use in high-speed aircraft, guided missile, and fire control system applications, withstands "the most severe vibration

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CONVERTERS

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BINARY CODED DECIMAL MODEL Capacity range from 0-1999 to 0-35,999.

Units for special codes or capacities are built to meet specific requirements.

SHOCK ENDURANCE.....20g
TEMPERATURE RANGE..−50° to 83°C min.
CODE DISCS.....Rhodium plated phenolic
PICKOFFS.....Multiple wire brush. Two pickoffs/channel
ROTATION.....Continuous, either direction.

RUGGED—NON-MAGNETIC—LONG LIFE
MAY BE READ WHILE IN MOTION

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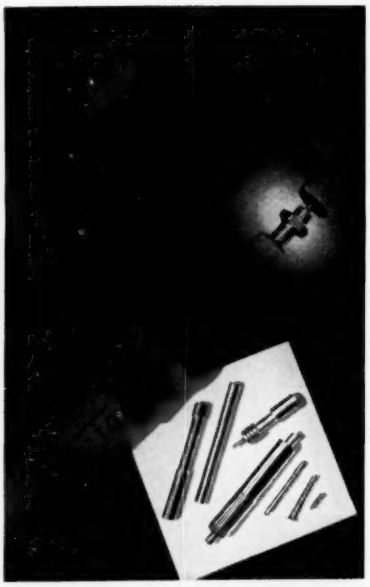

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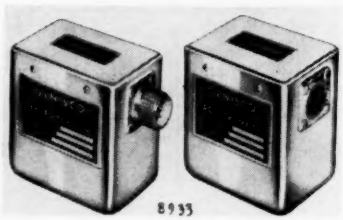
NEW INSTRUMENTS

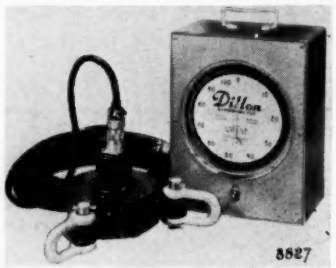


and stress environment." Movable mass is supported by a parallelogram leaf spring, imparting virtually friction-free straight-line motion to resistor brush. Balanced range units available in ranges from ±1 *G* to ±8 *G*, and up to ± *G* with reduced damping. (Unbalanced range units, and ultrasensitive units with ranges as low as ±0.1 *G* can be supplied.) —*Genisco Inc., 2233 Federal Ave., Los Angeles 64, Calif.*

For more information circle **225** on inquiry card.

REMOTE INDICATING DYNAMOMETER

New highly improved version of maker's remote-indicating dynamometer features much greater sensitivity.

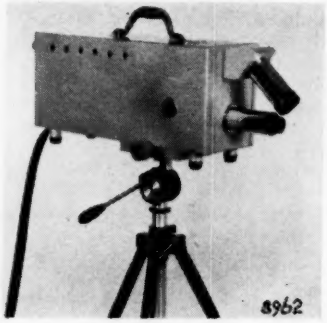


Instead of former 8" remote dial, a larger cabinet now accommodates a 10" dial. Circuitry has been improved. Synchros have increased stability and more freedom from flutter. Available in capacities from 0-500 lb to 0-100,000 lb.—*W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.*

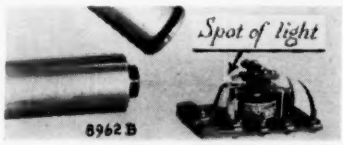
For more information circle **226** on inquiry card.

VIBRATION METER

New "Optron" is an optical and electronic instrument for measuring displacement and vibration. It can



measure amplitude, frequency and waveform of shake tables, vibration pickups; accelerometers, relay con-



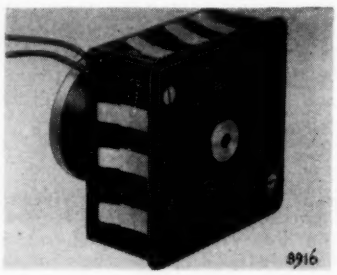
tacts, etc. No contact is made with the work: instrument employs a spot of light (effective dia 0.0001"), a cathode ray tube (frequency response 1 Mc), an optical system (100× microscope) and a multiplier photocell which servos spot to follow the motion. Accuracies of measurement are in microinches. Full-scale range can be as high as 10" with different optical systems. Photos show basic unit and "looking at" a relay.—*Optron Corp., 3526 State St., Santa Barbara, Calif.*

For more information circle **227** on inquiry card.

TIME, SEQUENCE, SPEED, FREQUENCY

CYCLING TIMER

New "Type 571" cam timer, in 1, 2, 3 or 4 poles, features small size, design simplicity, low cost and a wide range of speeds. Contacts: 30 amp resistive loads (and 1/3 hp) at 115 vac; speeds: 1 rpm to 1 rev in 8 days (faster speeds can be supplied with lower switch ratings). Switches are open blade, either sp-st or sp-dt. Three-level cams and a neutral position in sp-dt switches can be supplied to permit control of up to 8 load circuits with a 4-pole timer. All standard voltages, 50 or 60 cps. Time program is cut into factory-set cams securely positioned on a square shaft. Output shaft can be supplied.—*Cramer Controls Corp., Centerbrook, Conn.*



For more information circle **228** on inquiry card.

SIGNAL TIMER

New "Model 5700" automatically sounds time signals or reminders for factories, schools, hospitals, hotels, airports terminals, etc., at preset times every day, without manual attention. Signal duration can be set

LVDT MEASUREMENTS...

SCHAEVITZ Linear Variable Differential Transformers produce a voltage proportional to linear displacement. These units are widely used in measurement of displacement or distance. Variables such as force, weight, pressure and acceleration that can be expressed in terms of displacement can also be measured. Shielded and unshielded units are available in miniature and conventional sizes.

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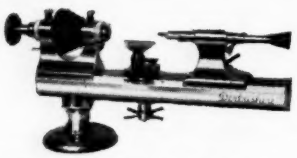
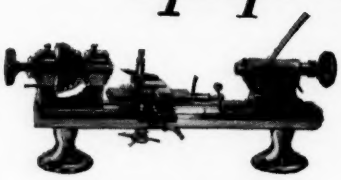
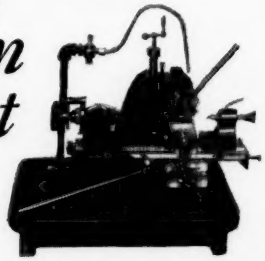


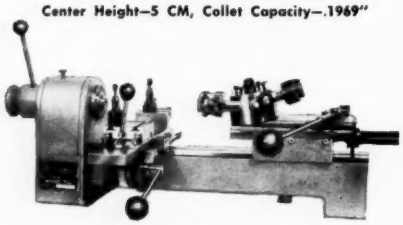
WEBSTER WHITCOMB 12" BED
Center Height—5 CM, Collet Capacity—.1969"



ELECT LATHE — 18" BED
Center Height—2.35" (6 CM)
Chuck Capacity—.004" to .315"

MICROMILL
2 Table Surfaces: 7⅞" x 2⅜" — 12" x 2⅜" — Takes Magnus Collets.

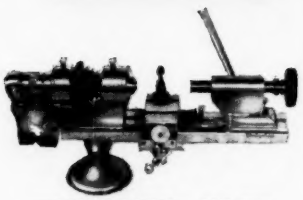




MODEL No. 750 — 22" BED
Center Height — 7.50 CM, Collet Capacity — .315"

If you have a problem...

. . . concerning small precision turning or milling, one of these lathes or the milling machine shown should solve it. Write for Catalog.



MAGNUS LATHE — 12" BED
Center Height — 5 CM
Collet Capacity — .315"

F. W. DERBYSHIRE, INC.
157 HIGH STREET
WALTHAM MASS.

For more information circle **82** on inquiry card.

WEKSLER

WHERE POSITIVE *Safety* IS ESSENTIAL!

FOR PRECISE MEASUREMENT OF PRESSURE

3½" - 4½" - 6" - 8½"
PRESSURE GAUGES
WITH
CHEMICAL DIAPHRAGM
ATTACHMENT

UTILITY TYPE
Pressure Ratings from
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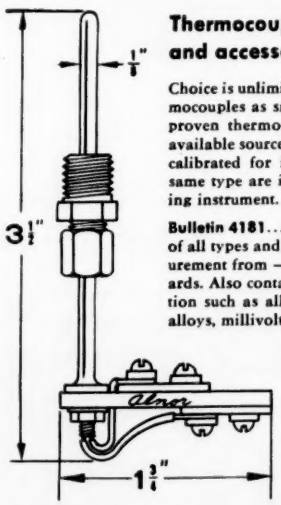
pyrometer supplies



Thermocouples, alloy wire, and accessories

Choice is unlimited at Alnor, where you'll find thermocouples as small as ⅛" O.D. and more unique, proven thermocouple designs than at any other available source. Each thermocouple is individually calibrated for its specific application—all of the same type are interchangeable without recalibrating instrument.

Bulletin 4181...lists thermocouples and accessories of all types and alloys for every temperature measurement from —100° F. to 3000° F., to ISA Standards. Also contains complete engineering information such as alloy curves, uses and limitations of alloys, millivolt relationship tables, etc.

Bulletin 4257...lists *surface* temperature thermocouples and accessories available from Alnor.

Circle bulletin number you want, attach this ad to your letterhead and mail to: Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

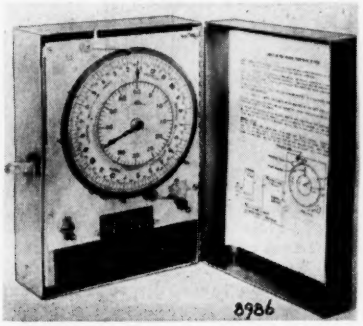
Model 3480 small pipeline thermocouple. Precision built to Alnor performance standards. Unit price: $9.00.

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

Alnor

For more information circle **84** on inquiry card.

for 5 to 60 sec.; minimum interval 5 min. between signals; hence an adequate number can be programmed during 24-hr period. "Skip-A-Day"

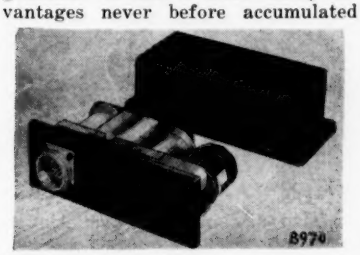


feature cuts off signal operation on weekends or holidays (optional equipment). Toggle switch and push button allow for cut-out of automatic operation or for manual sounding of signals, without altering the master cycle.—*Tork Time Controls Inc., Mount Vernon, N. Y.*

For more information circle **229** on inquiry card.

MULTIPLE-CHANNEL PROGRAM CONTROLLER

New "MPR-13 Multi-Channel programmer" is said to offer "many advantages never before accumulated

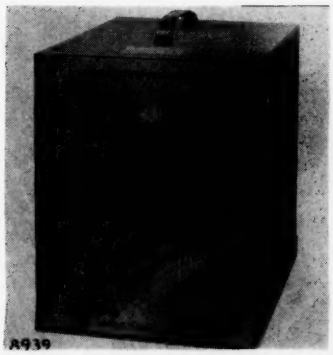


in one package." It is small and light, yet provides up to 13 channels for any type of electrical programming, either of a repeat-cycling or of a random nature. Its accuracy is one part in about 50,000 although it was designed to withstand missile and aircraft service. It utilizes an insulating tape, similar to 35mm film, advanced at a precise speed between 13 contactors, and perforated to control a group of electrically-operated devices. Weight 3.6 lb, size 2" x 3" x 6".—*Photographic Products Inc., 1000 No. Olive Street, Anaheim, Calif.*

For more information circle **230** on inquiry card.

MOTOR ACCELERATION AND FINE-SPEED CONTROLLER

New "CX25 Electronic Controller" provides accurate acceleration and speed control of shunt-wound dc motors from 1/50th to ¼ hp. Motor can be started at any speed from 1 to 2200 rpm either immediately or gradually over a half-minute interval. This is especially important in winding filaments, etc. Motor speed can

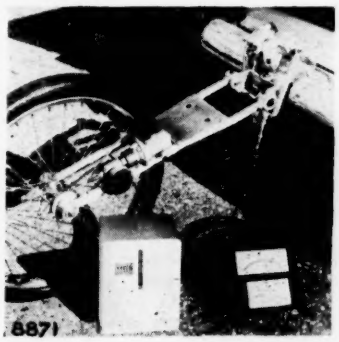


be accurately and steplessly varied by as little as 20 rpm with 270° of speed pot turning. Available for use in original equipment.—*Gerald K. Heller Co. 1819 Industrial Road, Las Vegas, Nevada*

For more information circle **231** on inquiry card.

VEHICLE SPEEDOMETER AND ODOMETER

New improved "Model 426 Trackmeter" quickly attaches to rear of an automobile, bus or truck. Its wheel



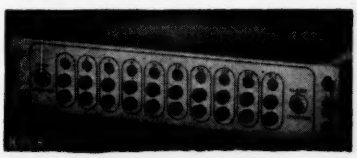
drives a tachometer generator; indicating speedometer (inside vehicle) is accurate to ½% and electronic counter registers one-foot distance increments.—*Performance Measurements Co., 15301 W. McNichols Road, Detroit 35, Mich.*

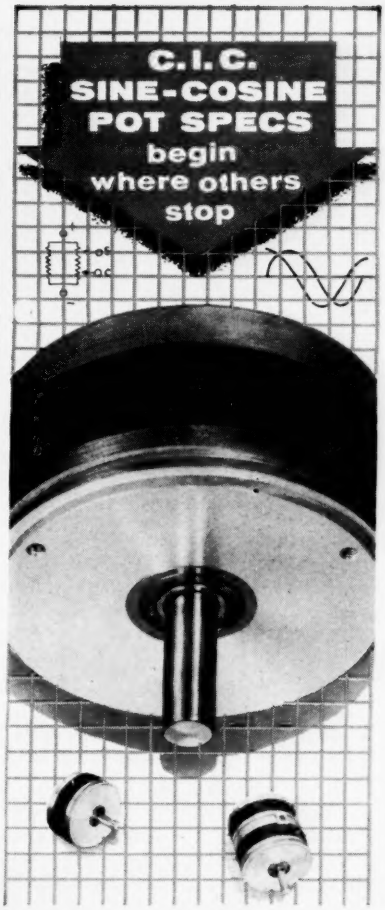
For more information circle **232** on inquiry card.

COUNTING

BINARY COUNTERS WITH REVERSIBLE OPERATION

New completely transistorized miniaturized ten-stage indicating binary counters feature both serial and parallel read-in and read-out. 18 vdc levels are available from either side





Infinite resolution and absolute dependability distinguish CIC ultra-precise Potentiometers. In the generation of the sine wave CIC Pots provide smooth, reliable performance, distortion free at all angles of rotation.

CIC carbon film Sine-Cosine Pots, the proven product of a unique research program, provide greater accuracy in smaller case sizes. Sizes range from 1" to 5" diameter with corresponding best conformities from .3% to .03%. Compensation for loading can be provided with **no loss of performance.**

At speeds in excess of 1,000 r.p.m. CIC guarantees life in excess of two million revolutions.

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Temperature Control
of Liquids or Air
the
HALLIKAINEN
Thermotrol
Temperature
Controller

Shell Development Co. Design

For controlling the temperature of a liquid or air, the Hallikainen-Shell Development Thermotrol is a general-purpose laboratory-temperature controller of high accuracy.

The temperature range of the Thermotrol is limited only by the resistance thermometer employed. Standard ranges available are from −70°C to 300°C. Other ranges on request.

The Thermotrol uses any one of three control methods: on-off, proportional or proportional with reset. Proportional control is achieved by time-cycle modulation.

Because of its unique design and custom assembly, the Thermotrol is not affected by variations in ambient temperature, line voltage, or load.

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Color Alarm, Thermometer Calibration Baths, Hydrogen Analyzer, Radiological Gas Analyzer, Alkylation Acid Analyzer . . . and other analytical instruments for continuous processes.

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1341 Seventh Street, Berkeley, Calif.

For more information circle **86** on inquiry card.

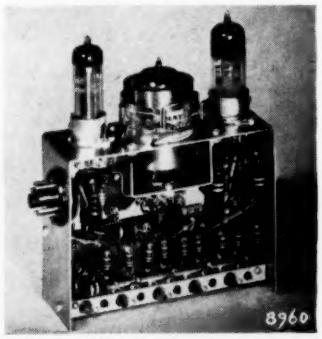
NEW INSTRUMENTS

of counter stages; and they can be directly loaded by other transistor stages. Internal amplifier strips can be incorporated to operate relays, low impedance busses, etc. Reversible counters have completely automatic internal switching. Pulses can be fed into forward and reverse inputs, and sum of the two inputs is made visible with neon indicators.—*Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa.*

For more information circle **233** on inquiry card.

ONE-MICROSECOND DECADE

New "Model S-101," for use in nuclear scalers and industrial counting equipment where extremely high



speed and reliability are required, is the only commercially-available decade strip with 1-usec resolution. Maximal reliability and high performance are obtained by use of a beam switching tube which contains 10-stable beam positions. Beside decade readout, a negative-output pulse, obtained as beam switching tube is stepped from 9 to 0, can be used to drive a mechanical register or another slower decade strip.—*Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill.*

For more information circle **234** on inquiry card.

HOLLOW-COIL PICKUP

New "Model 4920-AN Hollow Coil Proximity Pickup" featuring a connector located on the coil is said to

be ideal for counting small metal parts. It has a hollow phenolic table around which the sensing coil is wound, and utilizes a principle similar to that of military mine detector. It senses aluminum, brass or copper as well as iron and steel. Coil can be used as part of a chute or tube carrying metal parts. When electronic counters are used, counting rates can exceed 60,000 per minute. Available in 15 sizes from ¼" to over 3" dia; comes with an extra replaceable liner.—*Electro Products Laboratories, Inc., 4500 Ravenswood Ave., Chicago 40, Ill.*

For more information circle **235** on inquiry card.

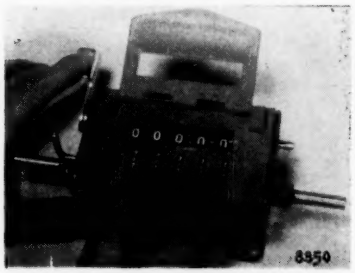
ELECTRIC COUNTERS

Two new "Sodeco" remote impulse counters have been developed: "Type TCeBZ4E" (4 digits) and "Type TCeBZ5E" (5 digits). Both have manual push-button zero reset; can be supplied for dc or ac (all standard voltages up to 220); can register up to 25 impulses per second; are designed for flush panel mounting and are supplied with protective housing.—*Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.*

For more information circle **236** on inquiry card.

PREDETERMINING COUNTERS

New predetermining counters are set to exact number of turns, strokes, pieces, etc.; automatically signal and/



or stop machine; are available for ratchet or rotary movement, for right or left hand drive; can be obtained with an over-all totalizer. Made by N. Zivy & Cie., Basel, Switzerland.—*Victor George Herman, 311 W. 97th St., New York 25, N. Y.*

For more information circle **237** on inquiry card.

SCINTILLATION COUNTER

New "Model SC-57 Low Background Well Scintillation Counter" features a background of approximately 100 counts per minute; comprises a standard Th (NaI) "SPG-3 Well Crystal and Photomultiplier Tube Assembly" mounted in a lead shield (supplied as integral part of instrument). This shield is about 21-¾" high by 9" dia. and provides 3" of lead around crystal and phototube assembly. Top shielding: two interlocking doors. Normal background of 1-¾" dia. by 2" well crystal in this shield is 95 to 101 cpm; normal background of same crystal in "SC-46 Well Crystal Shield" is about 500 cpm. Plateau slope of less than 1%/v/100v for a length of 200 v is reported. Phototube Amplifier As-

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WHAT'S NEW AT BRISTOL...

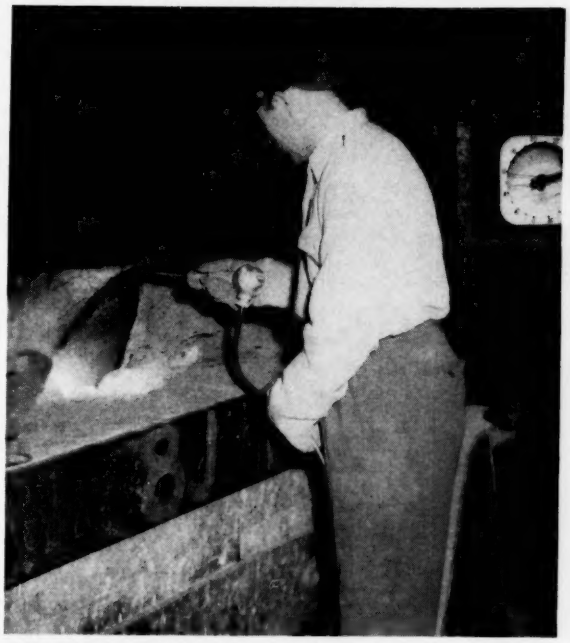

Photo courtesy General Thomas J. Rodman Laboratory, Watertown (Mass.) Arsenal.

NEW!

Immersion thermocouple for molten metals measures to 3200 F

The new Bristol portable immersion-type thermocouple is designed for direct measurements in melts of both ferrous and non-ferrous metals. Simplicity and operating economy are its key features.

Rugged tubes give economy. Latest result of Bristol's continuous development program in instruments and accessories for pyrometry, the new thermocouple's durable protection tube can take up to 14 dips in molten steel at 2700 F to 3200 F. Metals of lower melting temperatures such as brass and aluminum will give far longer life. What's more, replacement of the protection tube, plus reasonable care, allows re-use of the platinum sensing element—most expensive part of the unit.

Standard and "high-speed" models. The standard model of the new thermocouple—full response 30-45 seconds—features a Bristol metal-ceramic (LT-1) secondary protection tube. A special "high-speed" model—response 15-20 seconds—has a single quartz protection tube with quick-change thumbscrew, designed for easy replacement.

STOCK PARTS CUT COSTS, SPEED SERVICE

All parts in the new molten metal thermocouple are stock parts—a product of Bristol's careful design and advanced manufacturing methods. Result: lower first cost due to production economies and faster delivery on replacement parts.

Write today for complete data on this outstanding Bristol contribution to instrumentation in metallurgy. The Bristol Company, 154 Bristol Road, Waterbury 20, Connecticut. 7.1

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For more information circle **89** on inquiry card.

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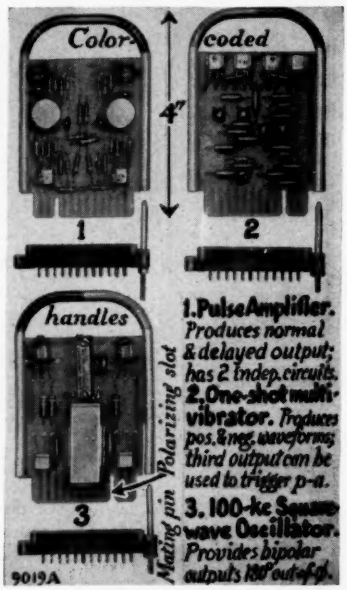
sembly is mounted on outside of well shield. Long term count stability of this counter is attributed in part to this design, which provides absolute thermal and optical isolation of photomultiplier tube from vacuum tubes. With amplifier by-pass switch, instrument can be used either as a spectrometry detector or as a standard detector for quarter-volt scaler inputs.—*Tracerlab, Inc.*, 1601 *Trapelo Road, Waltham, Mass.*

For more information circle **238** on inquiry card.

COMPUTING and DATA PROCESSING

TRANSISTORIZED PLUG-IN COMPUTER MODULES

New "Series M" models of maker's "3C-PACs" asynchronous digital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4"
1
2
handles
1. Pulse Amplifier. Produces normal & delayed output; has 2 indep. circuits.
2. One-shot multivibrator. Produces pos. & neg. waveforms; third output can be used to trigger p-a.
3. 100-kc Square-wave Oscillator. Provides bipolar output; 180° out-of-ph.
Mating pin Polarizing slot
3
9019A

plug-in circuit packages use transistors instead of vacuum tubes; can be combined to perform all digital operations; comprise twelve different circuits and three different "blanks."—*Computer Control Co., 92 Broad St., Wellesley 56, Mass.*

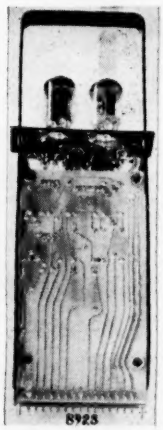
For more information circle **239** on inquiry card.

MAGNETIC RECORDING HEADS

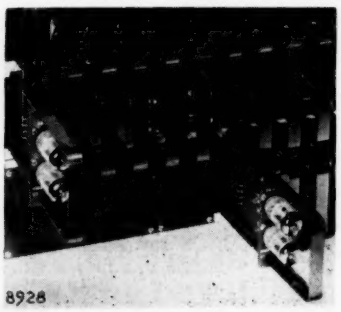
New "custom designed" magnetic recording heads for use in computers in aircraft and industrial applications are available in both single and multihead styles with up to 15 tracks; are specially laminated for better high-frequency response. Track positions and straightness are said to be held to "extreme accuracies." Impedance between tracks is ±10% on standard units, ±5% on custom units.—*Instrument Div., Thomas A. Edison Industries, West Orange, N. J.*

For more information circle **240** on inquiry card.

PLUG-IN COMPONENTS



New "Computer-Series" plug-ins are said to represent a refinement of building-block concept "to a degree hitherto unknown." Their performance has been engineered for application where ultra-conservative design at component level is essential because of system complexity. (For example, tube dissipation is derated 75% and cathode current derated 50%.) Full line includes flip-flops, shift register elements, dc "not" circuits, delay units, pulse mixer amplifiers, quadruple cathode followers, one-digit

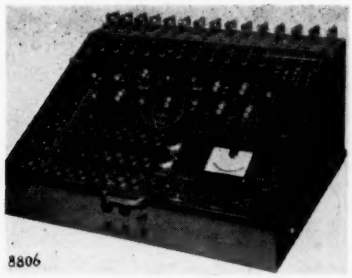


adder and one-digit subtractor matrixes, one shots, neon drivers, as well as 28 diode logic units incorporating "and" and "or" circuits. Mounting frames, each accommodating 15 plug-ins (30 tubes), are 3½" x 19" for installation in 19" racks. Frames can be stacked as desired. System can be completed by simple point-to-point wiring at rear of mounting frames. An in-circuit test fixture is also available to make plug-in units completely accessible for testing while in operation.—*Engineered Electronics Co., 506 E. First St., Santa Ana, Calif.*

For more information circle **241** on inquiry card.

INDUSTRIAL ELECTRONIC ANALOG COMPUTER

New "MAC" self-contained desk-top analog computer can solve "equations of more than usual difficulty"; em-



ploys a patchboard layout said to be unique in that it enables operator to "see" the problem in block form and to vary the coefficients during the problem run to quickly arrive at desired solution. It embodies fifteen dc operational amplifiers with minimum open-loop gain of 50,000, closed-loop gain of 10 (max load 10,000 ohms), power output 10 ma at 100 v; drift less than 0.5 mv in 3 min or 0.1%, frequency response flat to over 2000 cps at unity gain. Thirty coefficient pots can be set to 0.1% accuracy; two auxiliary 10-turn auxiliary pots. Two sets of operational relays with 8 circuits each. Function generator has 10 straight-line segments, variable-break-point voltages to 100 v, max slope 1 to 1. Optional: recorder (Sanborn or Brush) and dc 'scope for repetitive operation to "see" solution.—*Automation Service Co.*, 2123 *Outpost Drive, Hollywood* 28, *Calif.*

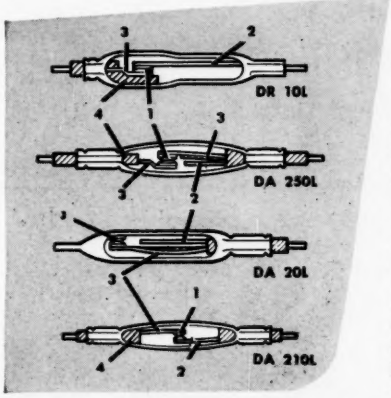
For more information circle **242** on inquiry card.

TAPE RECORDERS FOR INSTRUMENTATION

New "Series FR 1100" recorders feature modular electronic assemblies and tape-transport design improvements for greater flexibility and accuracy. From one to seven tracks of data can be recorded and reproduced at four tape speeds. Plug-in record and reproduce amplifiers provide quick interchange between direct, FM, and PWM recording modes. Record and reproduce heads are compatible with all three modes. Frequency response extends from dc to 100 kc. Transports are built for either ¼" or ½" tape on 10½" reels, with optional speed ranges of 7½, 15, 30 and 60 ips, or

How CHACE Thermostatic Bimetal Actuates the FRANKLIN DALES

Temp-Guard



The Temp-Guard is an extremely compact, self-contained and sealed tubular type circuit breaker manufactured by The Franklin Dales Co. Numerous variations of standard models are used in applications such as electric motors, operating on-off cycling systems, detecting fire and activating alarms, protecting electrical appliances, controlling regulating systems, automatically making or breaking current to solenoids, transformers, etc. The accuracy and dependability of this interesting device hinge upon its actuating element of Chace Thermostatic Bimetal.

The photo shows a typical Temp-Guard actual size. Others vary from 1 5/16" to 3 3/8" in length. The sectional drawings show four representative types of circuits; the DR models have the thermostatic bimetal element in contact with the case; the DA models have element insulated from the case. The numeral "2" indicates that case does not carry current. Parts numbered in the drawings are:

1. **Contacts**
2. **Thermostatic Bimetal Element**
3. **Conductive Strip**
4. **Insulation**

In all examples, the bimetal element deflects in response to changes in ambient temperature or heating of the element due to overload, making or breaking the circuit.

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For more information circle **93** on inquiry card.

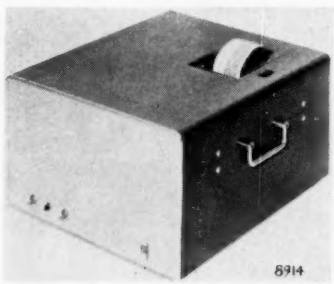
NEW INSTRUMENTS

3¾, 7½, 15 and 30 ips.—*Ampex Corp., 934 Charter St., Redwood City, Calif.*

For more information circle **243** on inquiry card.

DIGITAL PRINTER

New "Model 400A" converts electronic count information into printed form; features rapid print-out, parallel entry and up to 12-digit printing; uses no stepping switches; can be connected directly to other electronic counting instruments and will print, on standard adding machine tape, total count accumulated by basic instrument during each of its counting periods. It has been designed to operate from 4-line 1-2-2-4 binary code, thus can be used with most existing counting equipment without modification.—*Computer-Measurements Corp., 5528 Vineland Ave., N. Hollywood, Calif.*



For more information circle **244** on inquiry card.

COMPUTER TRANSISTORS

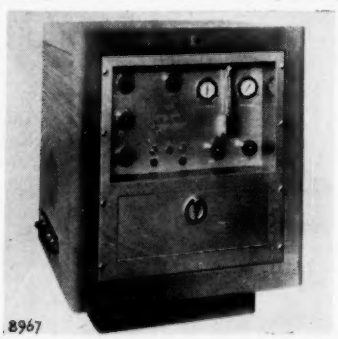
Three new high-speed switching transistors, "2N-315, 2N-316 and 2N-317," are of germanium alloy type intended for high-speed high-current switching. "2N-317 has, with minimal drive current, a typical switching speed of 0.3 usec at 400 ma of collector current. Series resistance of all three units when conducting is 0.5 ohm; nonconducting series resistance is as high as 10 megohms, approaching highest efficiency at high current levels.—*General Transistor Corp., 91-27 138th Place, Jamaica, L. I., N. Y.*

For more information circle **245** on inquiry card.

LABORATORY EQUIPMENT

LAB CRYOSTAT

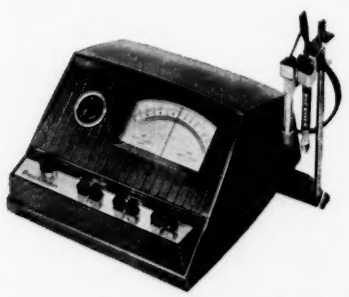
New "Model 147" nitrogen cryostat can cool infrared detectors to approximately −196°C; is a completely closed recirculating system: no danger of spilling or loss by evaporation; cooling heads (and hence detectors) can be operated in any position. Basic components are a miniature cooling head and a compressor-regulator assembly. Cooling head utilizes Joule-Thompson effect and principle of regenerative cooling. Various cooling heads available for cooling infrared detectors, for cooling traps in vacuum systems, etc.—*Perkin-Elmer Corp., Norwalk, Conn.*



For more information circle **246** on inquiry card.

AUTOMATIC pH METER

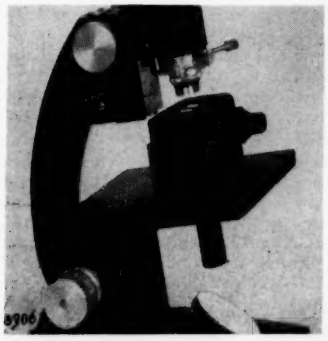
New "Zeromatic" line-operated automatic push button pH meter with drift-free amplifier can be adapted for potentiometer recorder output, automatic temperature compensation, and Karl Fischer titrations; has 0-14 pH scale range and two emf ranges: 700-0-700 mv and extended 0 to 1400 mv, latter particularly useful for redox titrations. Zero can be set at any point on 0-1400-mv scale. Operator reading error is minimized with anti-parallax mirror-backed scale; pH readings are accurate to 0.1 pH unit reproducible to 0.02 pH. No warm-up; instrument is left connected to 115-v source at all times—on STANDBY, and to make a pH reading, READ button is depressed. Push buttons also select manual or automatic temperature compensation and mv scale selection. Maker's "4990-83" glass electrode and "1170" reference electrode are supplied with instrument. Many other electrodes can also be used.—*Scientific Instruments Div., Beckman Instruments, Inc., 2500 Fullerton, Calif.*



For more information circle **247** on inquiry card.

VERSATILE REFRACTOMETER

New "Aminco-Jonnard Refractometer" equals performance of a 5-ft optical bench; enables making such



determinations as: concentration of extremely dilute solutions, dispersion of solutes, and refractive index differences for molecular weight determinations by light scattering. Among features: employs Rayleigh interference method (high sensitivity independent of physical size of lenses); measures refractive index differences to fifth decimal place; provides a typical measuring range of differences in refractive index of 0.002; does not require temperature control; requires a sample solution of only 1.6 ml.—*American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.*

For more information circle **248** on inquiry card.

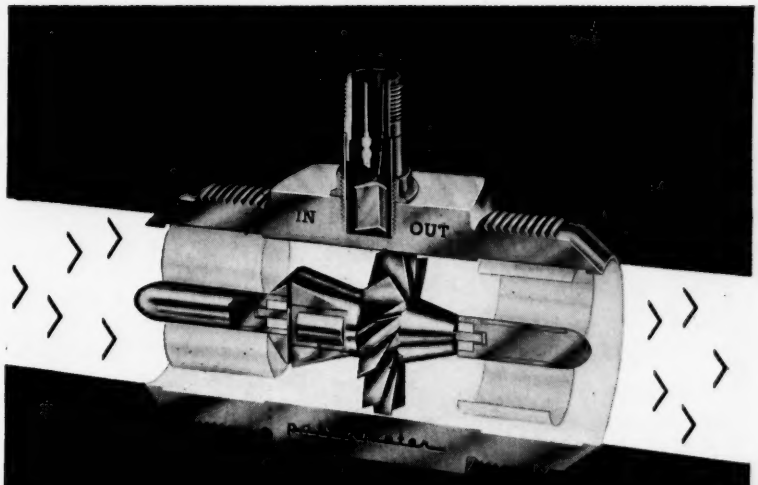
ALL-GLASS TRAP

New type of condensation trap, highly efficient for volatile compounds, makes possible quantitative condensation in vacuum manipulation of hydrocarbons and other volatile compounds; can also be used as a vacuum-system fore-trap and as a collector in air-pollution analyses. When it is immersed, coolant fills inner glass spiral and surrounds outer surface. Inner spiral provides at least 50% greater cold surface for condensation than conventional traps with same external dimensions. Upper extension of spiral is bent down as a return for liquid nitrogen coolant which pumps back into Dewar flask when trip is first immersed.—*California Scientific Glass Co., 35 S. Raymond Ave., Pasadena, Calif.*

For more information circle **249** on inquiry card.

SMOKE-SPOT DENSITOMETER

New "Model No. 157 Spot evaluator" reads smoke densities taken by A. I. S. I. Automatic Smoke Samplers



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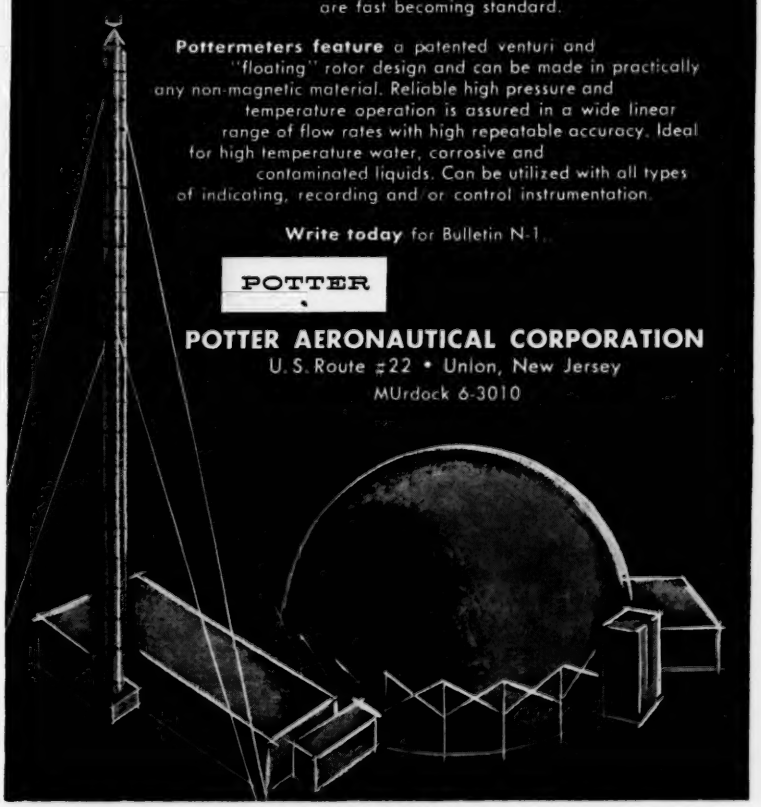

For more information circle **94** on inquiry card.

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For more information circle **96** on inquiry card.

NEW INSTRUMENTS

now being used in many communities. Improvements in design aid in simplifying operator's time-consuming and tiring job.—*Research Appliance Co., P. O. Box* 307, *Allison Park, Pa.*

For more information circle **250** on inquiry card.

ULTRA-HIGH-VACUUM VALVE

New "VAU-25" (designed by D. Alpert of Westinghouse) can handle pressures of 10^{-10} mm Hg and lower; is for use in ultra-high-vacuum laboratory systems where non-contamination and ability to be baked out are of highest importance. Effective conductance of Alpert valve for nitrogen is only 10^{-11} liter per second. Alpert valve will seal a vacuum system from a diffusion pump without contamination and inconvenience of a glass seal-off; is also useful in handling extremely pure gases, as in study of breakdown properties of noble gases. Valve can be baked out at temperatures up to 450°C without also baking driver threads (in separable part) and lubricant.—*Consolidated Electrodynamics Corp.,* 1775 *Mt. Read Blvd., Rochester* 3, *N. Y.*

For more information circle **251** on inquiry card.

SHOP EQUIPMENT AND MATERIALS

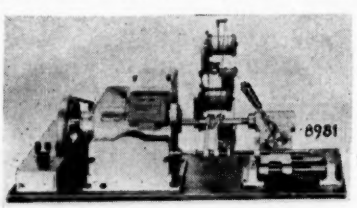
WIRE-WRAPPING TOOLS

New tools designed to speed electrical connections are powered either by electricity (illus.) or by air. Skinned wire is inserted in loading groove, which can be set in six different positions to make wire insertion easy from any angle. A notch in winding bit anchors wire, then bit is placed over terminal lug. Pressing trigger "shoots" connecting wire around terminal piece about six times per second under high tension. Result is a tightly-wound spiral forming a firm joint that withstands corrosion and vibration. Winding bits and sleeves are interchangeable without tools.—*Ingersoll-Rand,* 11 *Broadway, New York, N. Y.*

For more information circle **252** on inquiry card.

AUTOMATIC COIL WINDER

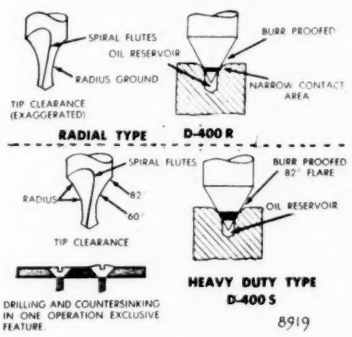
New "Model 700-AM" heavy-duty universal automatic coil winder winds self-supporting lattice-wound universal coils and single or pi-wound RF chokes up to 3" OD and 1¼" wide; can wind more than two universal type coils simultaneously. Feature: cam and yoke need not be disturbed for gear change: shuttle mechanism is divided by locating cam conveniently in front of machine and placing gears on top of winding head where they are immediately accessible. Max. loading distance between winding centers 8"; wire sizes 20 to 44.—*Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago* 30, *Ill.*



For more information circle **253** on inquiry card.

SAFETY CENTER DRILLS

New "D-400R" radial type center drill, available in sizes 1 through 8, has radius instead of sharp notch area of plain type which constitutes a fatigue point. Back taper to drill portion provides tip clearance which minimizes drill breakage. Spiral flutes prevent "jamming." This type is particularly well suited for precision work. ★New "D-400S" heavy-duty type center drill, available in sizes 11 through 18, retains advantages of radial type; is ground with an 82° top angle, effectively deburrs corners and is a combination tool for drilling and countersinking.—*The DoALL Company, Des Plaines, Illinois.*



For more information circle **254** on inquiry card.

10-FT ULTRASONIC CLEANING TANK

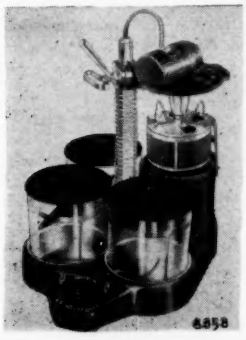
New "S-1080" tank, 10 ft long, is well suited to conveyorization, or for cleaning long items, by means of

ultrasonic energy. Its working fluid volume is 75 gal. Sixteen "Type B-36" transducers, installed along one side, are operated from one 2-kw "Model APT-400-B Sonogen" generator.—*Branson Instruments, Inc., 37 Brown House Rd., Stamford, Conn.*

For more information circle **255** on inquiry card.

CLEANING MACHINE

Newly improved "Industrial Precision Cleaning Machine" is said to embody every refinement to provide op-



timum efficiency in cleaning, rinsing, polishing and drying actions. It employs maker's Centrifugal Cleaning Action. Among features: column spring (which eases lifting of self-aligning column) automatically positions basket into jars and dryer; unbreakable jar covers; Monel meshwork basket; triple nesting basket to segregate small parts; Chromalox heater unit and separate motor-driven blower in drying chamber.—*L & R Mfg. Co., 577 Elm St., Arlington, N. J.*

For more information circle **256** on inquiry card.

INSTRUMENT CLEANING AND RINSING SOLUTIONS

New "Power Nofome" instrument cleaning solution and new "Instrument Rinsing Solution" were specifically designed to remove oil, grease, dirt and foreign matter from delicate components. Fingerprints,

P & B STRIKE SETTLED!

AN OPEN LETTER TO RELAY USERS

Potter & Brumfield, inc.

Dear Friends:

Ruthless violence, culminating on February 13 with the shooting of the four-month-old baby daughter of two of our employees, focused national attention on a recent strike at our Princeton, Indiana plant.

This unjustified strike was called on November 5, 1956 in the face of our "no strike" contract with Local 1459 of the International Association of Machinists. No demands or proposals for settling the strike were made by the Union. Two Company proposals were summarily rejected.

Settlement of the strike was reached on February 28, 1957.

Our plants in Laconia, New Hampshire and Franklin, Kentucky were not affected by the strike.

Production lines were shifted from Princeton to both Laconia and Franklin plants, and employment has been greatly increased at both locations. These plans were made before the work stoppage to increase production.

Production at Princeton was resumed on December 17th, and today a normal work force is manning the remaining lines. Until recently, the training of new workers restricted our productivity, but output now is at satisfactory levels.

With three plants to serve you, we pledge our continued efforts to provide you with relays of the finest quality. Our Engineering Department welcomes the opportunity to work with you on new designs and future projects.

Sincerely,

Dale V. Cropsey

Dale V. Cropsey
Vice President & Director of Sales

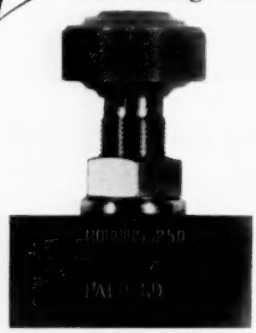
NOW!
3 PLANTS TO SERVE YOU

POTTER & BRUMFIELD, INC.

PRINCETON, INDIANA A Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

For more information circle **77** on inquiry card.

ROBBINS Leakproof Metering Valves



- Hi Vacuum to 6000 PSI.
- "O" Rings and Teflon or Nylon Seats are standard.
- Over-torquing cannot damage seat or needle as buffer plate and metering pin act as a forming die.
- Impossible to score needle or seat.
- Lifetime Valve—can be completely overhauled in a matter of minutes without disturbing plumbing or mounting.
- The most economical valve in the long run.

Write for further details.

ROBBINS AVIATION

1735 W. Florence Ave.
Los Angeles 47, Calif.

For more information circle **98** on inquiry card.

JOHN WORLEY JEWEL COMPANY 1900

SAPPHIRE JEWELS...

for

BEARINGS
THREAD GUIDES
DIES
GAGES
WEAR PARTS
STYLII

JOHN WORLEY JEWEL CO.

No. Falmouth, Massachusetts

For more information circle **99** on inquiry card.

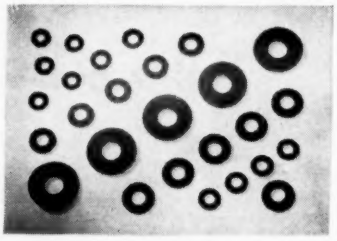
NEW INSTRUMENTS

lapping compound, tarnish, as well as dirt and lint, are completely removed leaving all parts with a brilliant finish, ready for final assembly.—*L & R Mfg. Co., 577 Elm St., Arlington, N. J.*

For more information circle **257** on inquiry card.

BLACK NYLON WASHERS

New line of black nylon washers comprises five sizes, to fit screws from No. 4 to ¼", carried in stock.

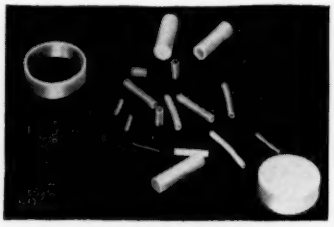


(Other sizes planned.) OD's from 1/32" to 11/16"; thicknesses from 0.020" to 0.040".—*Weckesser Co., 5701 Northwest Highway, Chicago 30, Ill.*

For more information circle **258** on inquiry card.

TEFLON TUBES, RODS, ETC.

New spaghetti tubing (both thin and standard walls) flexible tubing, rod and heavy-wall tubing, made from

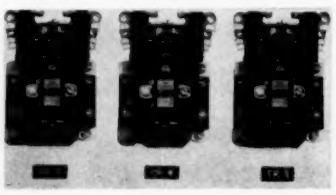


du Pont Teflon, are cut in lengths to meet individual requirements, feature ends cut clean and square without feathers or flattening and to an extremely high degree of accuracy, to any length from ¼" up.—*Pennsylvania Fluorocarbon Co., Inc., 1115 N. 38th St., Philadelphia 4, Pa.*

For more information circle **259** on inquiry card.

NAME PLATES

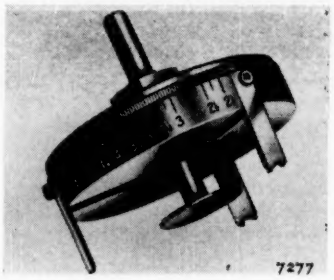
New low-cost fiber or aluminum name plates for identifying control panel components such as relays, switches, etc., can be used also to identify motors, switches, and other equipment mounted on machinery. Fiber plates have clear distinctive engraved letters or numbers on a black or dark background; aluminum plates have white letters or numbers engraved on a black anodized aluminum background. Identifications are JIC standard. Plates are ⅜" x 1". Adhesive on back of each plate permits fast, easy application, with strong, permanent, heat-resisting bond. Markings other than JIC standard can be obtained on special order.—*E.C.P. Corp., 6808 Wade Park Ave., Cleveland 3, Ohio.*



For more information circle **260** on inquiry card.

ROUND-HOLE SAW

New "Model 500 Dial Saw," for use with heavy-duty equipment, uses same principle of dial setting as previous



"Models 250, 375 and 400"; cuts any size from 2¼" to 5" dia. Available in three shank types: "Model 500" with ½" straight shank; "500A" ¾" straight shank; "501" Morse No. 2 taper shank.—*Robertson and Ruth, Box 534, Elmhurst, Illinois.*

For more information circle **261** on inquiry card.

ADHESIVE FOR FOIL

New bonding film type of adhesive, for maker's "Metal-Cal" aluminum foil appliqué, allows quick applica-

tions which are permanent yet require no application preparation time; is available for both heat-and-pressure and solvent-activated types. Heat-and-pressure application can be made in 5 sec and activator can be set up to activate adhesive in 0.1 sec.—*C & H Supply Co., 415 E. Beach Ave., Inglewood 3, Calif.*

For more information circle **262** on inquiry card.

THERMOSTAT METALS

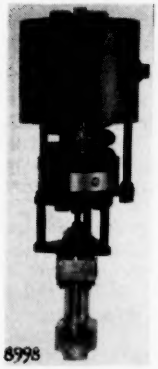
Two new thermostat metals are for instrumentation components, such as fire detector clocks, meteorological devices, pyrometers, altimeters, demand meters, etc. One possesses a useful deflection range of −100°F to 700°F with max sensitivity from 0 to 300°F; high deflection rate, high torque, good

strength properties up to 800°F, high electrical resistivity and good corrosion resistance. The other has a wide range of linear deflections between −50°F and 700°F with max sensitivity from 200°F to 600°F; high deflection rate and high torque rate. Both are produced in thicknesses down to 0.001", widths down to 0.093", in coils or lengths cut to order; also spiral and helical coils, flat blades, U-shapes, cantilever strips and other elements.—*American Silver Co., Inc., 36-07 Prince St., Flushing 54, N. Y.*

For more information circle **263** on inquiry card.

VALVES, etc.

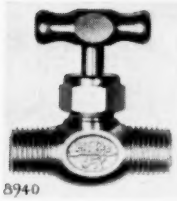
VALVE ACTUATORS


8998

New complete line of all metal actuators for control valves for use under difficult conditions such as atomic radiation, high temperatures and corrosion, is for both pneumatic and hydraulic control systems. New actuators are available with suitable valves or as additions to existing valve installations. Some are field reversible "air to open" or "air to close". For use in highly corrosive atmospheres, one model with stainless bellows and stem, and cadmium-plated cold-rolled steel, is available in three ranges of signal pressures (3-15, 6-30 and 9-45 psi); max thrust about 3,000 lb.—*Fulton Syphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville 1, Tenn.*

For more information circle **264** on inquiry card.

NEEDLE VALVES


8940

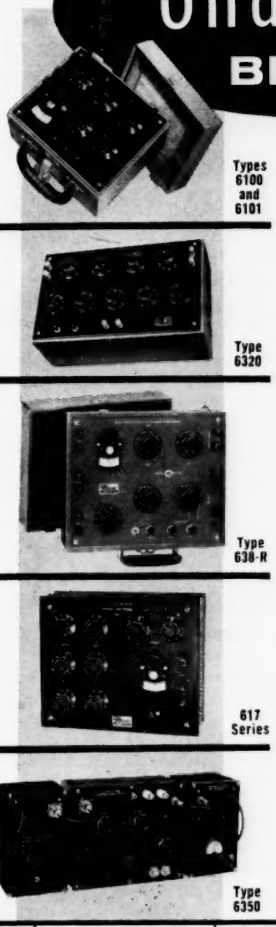
New small forged brass needle valves, angle or straight pattern, employ O-ring stem seal, are designed for instrument air lines, test panels, graphic panels etc. Choice of vee point stem for accurate flow control or blunt point stem for full flow. Bodies will withstand 2000 psi. Male or female pipe thread or Swagelok tube ends. Available for panel mounting.—*Hoke, Inc., 231 S. Dean St., Englewood, N. J.*

For more information circle **265** on inquiry card.

VALVE MANIFOLD

New cast-aluminum manifold affords economical and efficient multiple mounting of "Speed King" 2-, 3-

Shallcross
BRIDGES



ACCURATE dc RESISTANCE MEASUREMENTS

. . . 1 micro-ohm to 10^6 megohms

Among the many bridges manufactured by Shallcross, these six have become virtually "standards" for general-purpose resistance measurements. Each is easy to operate and ruggedly constructed to maintain accuracy and stability in every kind of field and laboratory service. Switch decks are inside the case for minimum maintenance.

Of special interest are the 617 Series Limit Bridges. These provide direct "GO-NO GO" production line resistor testing for any percent tolerance spread from ±0.1% to ±20%.

NEW BULLETIN L-19B contains full specifications for each instrument. For your copy write to: SHALLCROSS MANUFACTURING COMPANY, 510 Pusey Avenue, Collingdale, Pa.

Model Number	Measurement Accuracy	Maximum Setting	Minimum Setting	Circuit	Special Features
6100	±0.1% +0.01Ω (.1Ω to 1.011 MegΩ)	1.011 MegΩ	0.001Ω	Fault Location—Wheatstone	Fault Location by Murray, Varley, Hilborn & Fisher Loop Tests.
6101	±0.1% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	0.001Ω	Wheatstone	Four dial rheostat usable as decade box.
6320	±0.02% +0.01Ω (1Ω to 11.11 MegΩ)	111.11 MegΩ	0.00001Ω	Wheatstone	Most accurate five dial Shallcross bridge for direct resistance measurement.
	±0.05% to ±20% on separate "+" and "−" percent selectors. (1Ω to 10 MegΩ)	11.111 MegΩ	0.0001Ω	Percent Limit	Rapid "GO-NO GO" percent limit testing. Built-in adjustable comparison standard.
638-R	±0.75% or better (.001Ω to 1Ω)	11.11Ω	0.000001Ω	Kelvin	Overlapping Kelvin and Wheatstone ranges selected with single ratio dial.
	±0.2% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	.001Ω	Wheatstone	
6350	±1%, (10Ω to 10 MegΩ) ±2%, (10 MegΩ to 10,000 MegΩ) ±5%, (above 10,000 MegΩ)	1.111 x 10^4 MegΩ	0.01Ω	Wheatstone with d-c Amplifier	Modular construction dual range power supply, null indicator-amplifier, for 115V. 60 cycle operation.
617 Series	±0.1% to ±20% on separate "+" and "−" selectors from a minimum resistance consistent with number of dials in use to the maximum settings.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Percent Limit	For rapid "GO-NO GO" percent limit testing. Hand or foot operated for production testing. All models also usable for direct resistance measurements. Binding post for external d-c power supply.
	†±0.2% +0.01Ω from a minimum consistent with number of dials in use to the maximum setting.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Wheatstone	

† Except 617B and 617J ±0.1% ±0.01Ω. * Except 617G, 0.01Ω.

For more information circle **100** on inquiry card.

FREED
VARIABLE TEST VOLTAGE MEGOHMMETER NO. 1620

The Freed Type 1620 Megohmmeter is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.

Components such as transformers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor.

- Resistance — 0.1 megohms to 4,000,000 megohms.
- Voltage — variable, 50 - 1000 volts.
- Accurate — plus or minus 5% on all ranges.
- Simple — for use by unskilled operators.
- Safe — high voltage relay controlled.
- Self-contained — AC operated.

OTHER MEGOHMMETERS AVAILABLE

Type 1620C Megohmmeter — a type 1620 with additional circuitry for testing capacitors.
Type 1020B Megohmmeter — a 500 volt fixed test potential. Range 1 megohm to 2 million megohms.
Type 2030 Portable Megohmmeter — battery operated, 500 volt test potential. Range 1 megohm to 10 million megohms.

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.
1707 Weirfield St., Brooklyn (Ridgewood) 27, N.Y.
For more information circle **101** on inquiry card.

MACHINE-DIVIDED SCALES

Made with latest SIP Swiss Automatic Dividing Machines

LINEAR
Accuracy to ±5 microns (0.0002")
Any scale pattern—Any line width—Any material

CIRCULAR
Accuracy to ±5 seconds

FINE MACHINE ENGRAVING
Scales, Dials, Drums, Rods, Panels

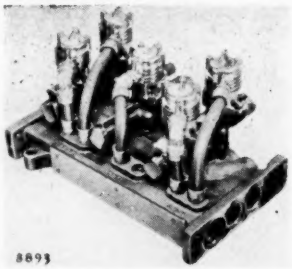
ACCURATELY ETCHED RETICLES
Made to any specified pattern and dimensions

PROMPT DELIVERY
on large or small quantities.

L. C. RENICK CO.
3820 So. 59th Court, Cicero 50, Illinois

For more information circle **102** on inquiry card.

NEW INSTRUMENTS

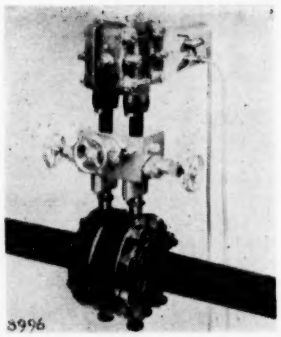


or 4-way valves in any desired combination; is available in 2 and 3 station types; has full-length inlet and exhaust ports, both 1" NPT, common to all valve stations. Electrical wiring is run through a 1¼" NPT conduit passage, with one access cover for all stations to simplify wiring. Manifolds are designed with side or bottom cylinder porting to facilitate piping. Holes for mounting manifold and valve assembly are also provided. —*Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.*

For more information circle **266** on inquiry card.

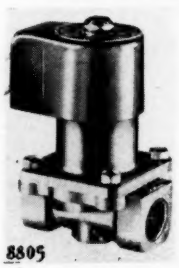
THREE-VALVE MANIFOLD

New compact 3-valve manifold, for all makes of pneumatic or electric flow transmitters, cuts leak points in half; fits flanges and/or fittings regardless of orifice plate thickness, is rated at 1500 psi at 350°F (higher ratings available); comprises two full-open gate block valves and one needle by-pass valve; permits venting or draining in any position, also seal and purge simultaneously on corrosive fluids. Straight-through design permits "rodding-out" flange taps under pressure. Easy to check during "turn-arounds." Special materials available. —*Instrument Manifolds Co., 3174 E. 22nd St., Tulsa, Okla.*



For more information circle **267** on inquiry card.

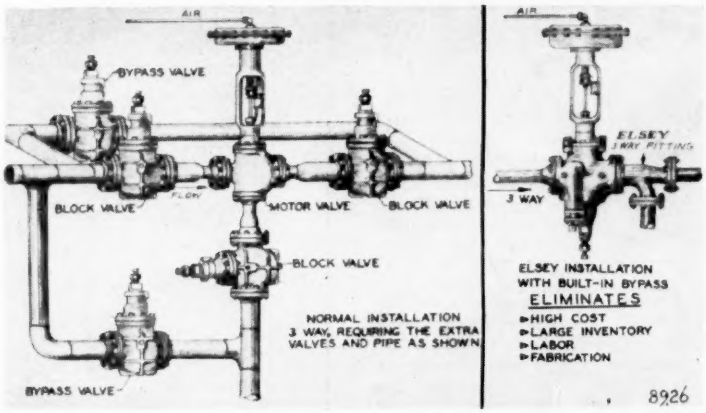
STEAM SOLENOID VALVE



New "Bulletin 8222A" internal-pilot-operated packless two-way valve can be used in a variety of applications for automatic control of flow of steam, hot fluids or gases (up to 400°F). Forged brass body and bonnet. Teflon discs assure tight shut-off without maintenance problems. Valves have low power consumption; can be mounted in any position.—*Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.*

For more information circle **268** on inquiry card.

CONTROL VALVE WITH INTEGRAL AUXILIARIES



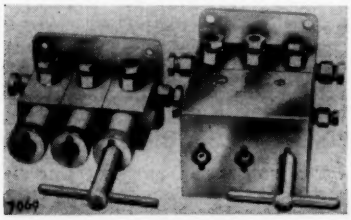
complete conventional diaphragm control-valve installation, either standard or three-way (latter illustrated). It combines in one valve body all repair and arrangement principles of control valve together with shut-off and

New "Control Valve Unit" replaces by-pass devices. Repair or replacement of valve seats, or change from n-o to n-c, can be accomplished with valve in line and under pressure. Available in sizes from ⅜" x ½" to 8" x 10" (10" x 12" and 12" x 16" special), 400-psi and 300-psi.—*Elsey Corporation, Bartlesville, Oklahoma.*

For more information circle **269** on inquiry card.

PNEUMATIC MANIFOLD VALVES

Two new manifold valves for pneumatic installations feature fool-proof manifold operation and quick, air-

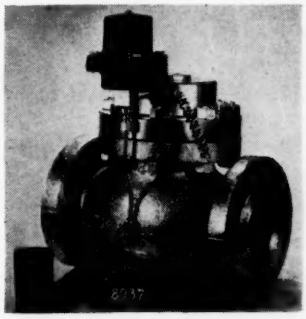


tight action: no need of turning and tightening handwheels. "Model 1583 Manifold Valve" (left) comprises a 2-position piston sliding in a 2-port cylinder; is normally closed; is moved to open position when key is inserted and given a quarter-turn. When key is withdrawn, valve closed under spring tension. Key is attached to a valve by a ball chain. "Model 1563 Duplex Manifold Valve (right) comprises two mechanically-linked 2-port 2-piston piston-type valves normally held closed by spring tension. When key is inserted and given a quarter-turn, both valves are simultaneously moved to open position; close automatically upon withdrawal of key.—*Petrometer Corp.*, 43-22 10*th St., Long Island City* 1, *N. Y.*

For more information circle **270** on inquiry card.

CAST STEEL SOLENOID VALVES

New line of cast steel solenoid valves for liquids to 600 psi is available in sizes 2", 2½", 3" and 4";



globe or angle pattern with screwed or flanged pipe ends. Features include renewable seat rings, unbreakable piston rings and packless operation over a wide pressure range. New valves eliminate damaging hammer and shock in automatic or remote control. Coils are unconditionally guaranteed; are interchangeable among sizes and with all other Gould valves. Photo shows a 3" "Type EO-2" with explosion-proof coil housing.—*J. D. Gould Co.*, 4707 *Massachusetts Ave., Indianapolis* 18, *Ind.*

For more information circle **271** on inquiry card.

The **KIN TEL MODEL 111** amplifier provides the lowest drift of any commercially available broadband d-c amplifier. The unique circuit incorporates **KIN TEL's** proven chopper amplifier system to provide unsurpassed dynamic performance—unaffected by load or gain changes. Available in a single-unit cabinet or a six-amplifier rack-mountable module only 19 inches wide, the **Model 111** is ideal for data reduction facilities, or as a strain gage amplifier, recorder driven amplifier, or general purpose laboratory amplifier.

SPECIFICATIONS

- ± 2 uv equivalent input drift
- Integral power supply
- ± 35V, ± 40 ma output
- 100,000 Ω input impedance
- 0 to 1000 gain in ten steps
- ± 1% gain accuracy
- 5 uv peak equivalent input noise
- Price (Single) Amplifier $550.00

Representatives in All Major Cities

KIN TEL

[KAY LAB]

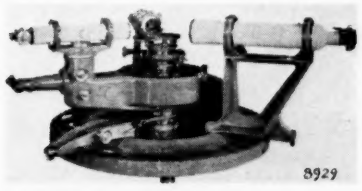
5725 KEARNY VILLA ROAD
SAN DIEGO 11, CALIFORNIA

For more information circle **90** on inquiry card.

DIMENSIONAL GAGING, INSPECTION

PRECISION GONIOMETER

New "Guild-Watts Spectrometer" measures angles of prism faces, gage block combinations, instrument assemblies, etc. One accurately-divided circle is used to read both table and telescope positions; either workpiece (mounted on table) or telescope can

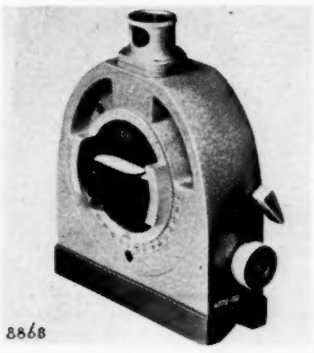


be rotated independently and with or without circle. Circle reading corrects centering errors; it is direct to 0.1 second. Two telescopes are provided: one mounted on main bearing and properly counterbalanced; the other mounted independently on a pillar which fits into a ring on base of instrument. A collimator can be set to any desired position around ring on base.—*Engis Equipment Co.*, 431 *S. Dearborn St., Chicago* 5, *Ill.*

For more information circle **272** on inquiry card.

PRECISION CLINOMETER

New light-weight Leitz Precision Clinometer is claimed to have several novel features that help to widen ap-



plication of this type of instrument. Body is an aluminum casting and base is magnetized. Separate longitudinal and cross levels with individual fine adjustment screws for longitudinal level. Double vernier in microscope corresponds with circle graduations to give readings in degrees, minutes and 30 seconds. Accuracy of op-

Uniflow Springless type 500 air to open—air to close —½" to 6" pneumatic or electric pneumatic

select either type
but select . . .

Uniflow

air operated Saunders patent type control valves

In chemical, slurry, water treating and high vacuum installations, UNIFLOW Valves are fast becoming most popular because not only are they low in cost, but highest quality requirements are met and maintained.

Uniflow Air Operated Control Valves employ Saunders patent valve features—the valve that requires no stuffing box or stem packing.

with positioner

without positioner

Why not learn how you can fill your difficult control valve needs quickly—economically.

WRITE FOR BULLETIN 114R

UNIFLOW VALVE CORPORATION

19 Quine St. Cranford, New Jersey

For more information circle **103** on inquiry card.

Why "CHOKE" your soldering iron?

— just "CRADLE" it with a

HEXACON

HATCHET SOLDERING IRON

The operator has to "choke" the conventional straight iron to hold it, whereas the HEXACON HATCHET IRON "cradles" in the hand with no perceptible grip whatsoever — *thus relieving hand strain* and eliminating the "heavy hand", the cause of poorly soldered joints. Because HEXACON HATCHET IRONS are *perfectly balanced* in weight, they enable the operator to solder in a natural position and relieve fatigue of arm and back.

Send for new circular No. 70H giving more details and comparative competitive performance data.

A COMPLETE LINE OF HATCHET IRONS BY HEXACON —*Originator and Pioneer*

CAT. NO.	WATTS	TIP DIA.	PRICE
25H	25	1/8"	$ 6.50
26H	30	3/16"	6.50
30H	60	1/4"	6.75
70H	80	3/8"	11.00
100H	100	3/8"	12.00
150H	150	3/8"	12.75
151H	175	1/2"	13.50
200H	200	5/8"	14.00
300H	300	7/8"	18.25

HEXACON ELECTRIC COMPANY

506 West Clay Ave., Roselle Park, New Jersey

INDUSTRY'S No. 1 HEXACON SOLDERING IRON

For more information circle **104** on inquiry card.

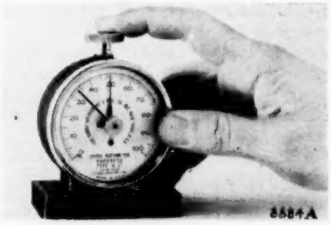
tical circle and sensitivity of level is 15 seconds of arc.—*Opto-Metric Tools, Inc., 137 Varick St., New York, N. Y.*

For more information circle **273** on inquiry card.

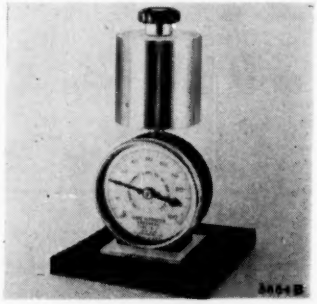
MECHANICAL TESTING

PORTABLE HARDNESS TESTERS

Two new special-purpose "Durometers": (A) "Maximum-reading Durometer," modification of standard



"Type A-2" (ASTM D676), accurately measures cold flow or "creep" of elastomers. Note: useful new Operating Stand is not shown in illustration. (B) "Constant-load Durome-

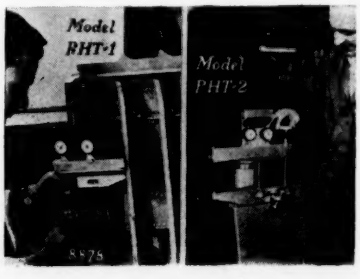


ter," also a modification of "Type A-2," minimizes possibility of variations in readings resulting from inconstant pressures of manual application to specimen. Combined mass of dead weight and its holding screw is 822 grams (per ASTM D676).—*The Shore Instrument & Mfg. Co., Inc., 90-35 Van Wyck Expressway, Jamaica, N. Y.*

For more information circle **274** on inquiry card.

PORTABLE HARDNESS TESTERS

New "Model PTH-1" (capacity 4½" diameter or thickness) and "Model PTH-2" (12") for on-the-spot Rock-

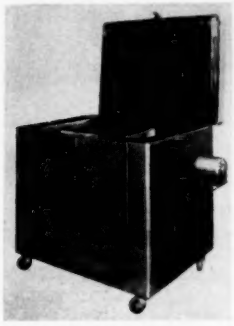


well readings (scales A, B, C, D, F and G) can test parts inaccessible to bench-type testers; are ready for instant use; cost much less than permanently-installed testers. They perform true Rockwell test with standard indentors and standard Rockwell loads. Dials are marked in standard red and black; are large enough to be read without magnifier. Standard equipment includes convex, flat and vee anvils, three test blocks, diamond and $\frac{1}{16}$" ball indentors, and carrying case. —*Riehle Testing Machines (Div. A.M.&M), East Moline, Illinois.*

For more information circle **275** on inquiry card.

ENVIRONMENT TEST CHAMBER

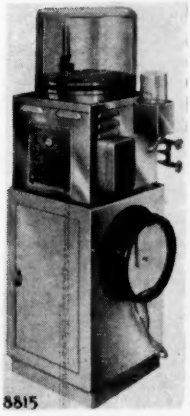
New "Model D-104" automatically-controlled 5 cu. ft. multi-environment chamber can drop working tempera-



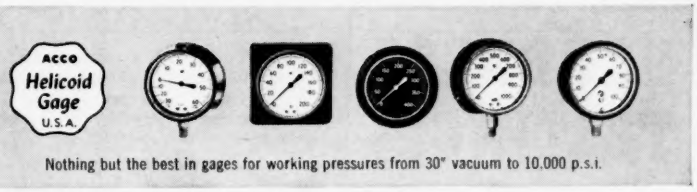
ture from room level to −65°F in five minutes and raise to 400°F in ten minutes; maintains pre-selected high or low temperatures during continuous operation within 2F° between −100°F and 400°F. Its relatively large (100-lb) dry ice capacity is said to permit completion of most low temperature work without recharging ice.—*Mantec, Inc., Dept. CD, 126 Maryland St., El Segundo, Calif.*

For more information circle **276** on inquiry card.

PROGRAMMED HUMIDITY CHAMBER

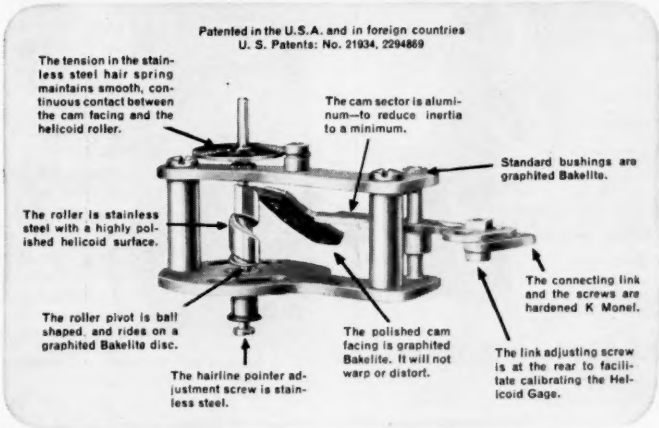


New model of "Vapor-Temp Controlled Relative Humidity Chamber" features an automatically controlled two-point programmer and recorder system which meets large majority of MIL, JAN, ASTM and NEMA test specs. "Dual Microtrol" automatically holds low-condition wet and dry bulb temperatures for desired number of hours until timer trips. Timer immediately transfers control action to other set of controllers and



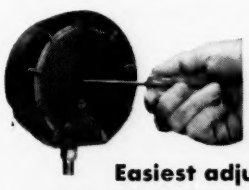
Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294859
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.



Easiest adjustment and calibration

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

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AMERICAN CHAIN & CABLE

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ACCO TRADE MARK

For more information circle **105** on inquiry card.

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For more information circle **106** on inquiry card.

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Catalog 25

For more information circle **107** on inquiry card.

NEW INSTRUMENTS

humidity cabinet rises to high condition, holding for desired number of hours until timer trips again transferring control action to initial setting. Dry bulb temperatures controlled from room to 170°F within 1F°, relative humidity from 20% to 90% (depending upon dry bulb temperature) within 1% RH.—*Blue M Electric Co., Blue Island, Ill.*

For more information circle **277** on inquiry card.

ELECTRICAL TESTING

RATIO RECORDER

New "T/Plotter" is said to save 50% to 75% of vibration laboratory testing time. It eliminates data reduction; plots a complete vibration transmissibility curve in strip-chart form during vibration test cycle for immediate evaluation. Same advantages for lab dynamic test ac voltages (forces, flow-rates, displacements, etc.) fed to "T-Plotter" from two pickups: these are plotted as one continuous curve on a strip chart. Servos use null method for highest accuracy. Four full-scale settings permit plotting ratios 0-0.2/1/10/100; ranges for ratio's denominator 0-20/50/100/200/500 mv; and 0-1/2/5/10 v; sixteen chart speeds from 6" to 960" per hour in 16 steps quickly and easily selected with "Insco" chart-speed changer. Remotely controlled pen marks time pips or other indices. —*Dept. T, Barry Controls Inc., 957 Pleasant St., Watertown 72, Mass.*

For more information circle **278** on inquiry card.

FREQUENCY CALIBRATOR

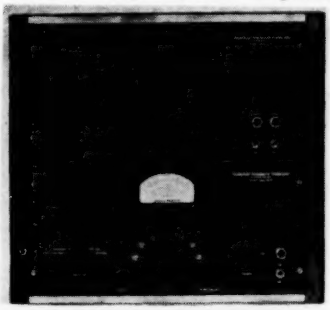
New "Model TMC-307d 7-point Frequency Calibrator," for telemetering applications, sequentially furnishes

seven equally-spaced frequencies per channel for all RDB channels within end limits of ±7.5%, and within end limits of ±15% for upper five channels. Other end limits and spacings can be furnished. Channel and frequency point switching can be either manual or automatic. Accuracy 0.02%. —*Panoramic Radio Products, Inc. 10 S. 2nd Ave., Mount Vernon, N. Y.*

For more information circle **279** on inquiry card.

FREQUENCY ANALYZER

New "TP-625" determines frequency-amplitude spectrum of a random wave and frequency and amplitude

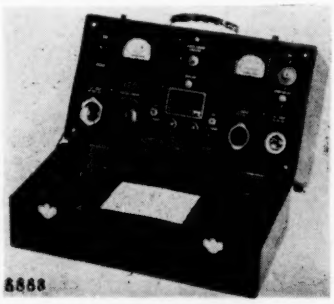


of individual components of a periodic complex wave within frequency range of 2 to 25,000 cps. Wave components are measured in decibels and in percent of total signal. Results are displayed on a calibrated attenuator and on an indicator; outputs are also provided to drive a recorder.—*Technical Products Co., Instrument Div., 6670 Lexington Ave., Los Angeles 38, Calif.*

For more information circle **280** on inquiry card.

H-V INSULATION TESTERS

New "Model T-4," designed to perform insulation leakage resistance measurements and nondestructive



breakdown tests on all types of equipment and materials, is continuously variable from 1 to 15 kv in one range; has an output resistance of 100 megohms, therefore limiting all leakage currents to less than 150 microamps. This prevents formation of destructive arcs when breakdown voltage of test specimen is reached and permits visual inspection of point of breakdown. It also renders equipment completely safe since a direct current of 150 microamps cannot produce a sus-

tained muscular contraction after accidental physical contact.—*Transitron, Inc.*, 186 *Granite St., Manchester, N. H.*

For more information circle **281** on inquiry card.

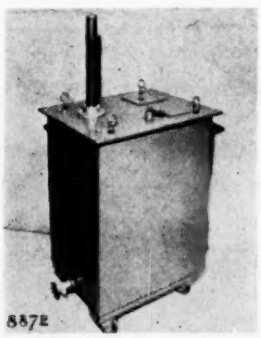
HIGH-VOLTAGE TESTERS

New "Series H" is an improved line of "Sensitive HiPot Testers" which automatically deenergize high voltage when leakage current in samples reach 5 microamps. It includes models from 2 kv up to 120 kv, and special units can be custom built. Smaller units are adjustable up to 1000 microamps and larger units to 5000 microamps. "Series H" testers avoid "brute force" method of burning up equipment and components when testing for leakage; allow convenient and accurate dielectric testing of equipment, components and materials. Their high sensitivity shows up leakage currents in "insulation which appear to be perfect on less sensitive instruments."—*Peschel Electronics Inc.*, 17 *Garden St., New Rochelle, N. Y.*

For more information circle **282** on inquiry card.

100 KV DC TEST SET

New non-destructive very-high-potential unit, for insulation testing of samples, or full reel tank testing,

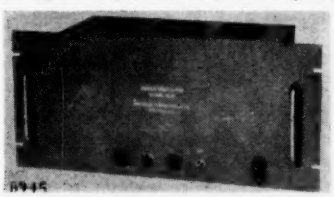


offers a preferred method of checking insulation of cables; meets new IPCEA standards as well as MIL, JAN and ASTM specs. Among features: 0-100-kv output; automatic output shorting; external interlock provision.—*Peschel Electronics Inc.*, 19 *Garden Street, New Rochelle, N. Y.*

For more information circle **283** on inquiry card.

POWER OSCILLATOR

New "Model 1500" can be employed as a precision 400-cps source to energize synchros, resolvers, motors, etc.



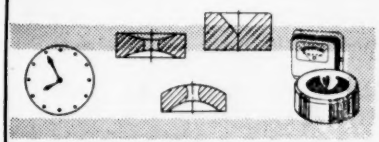
PRECISION

defined by the dictionary

. . . . "the quality or state of being precise; accuracy; mechanical exactness."

defined by an instrument maker . . .

Swiss American



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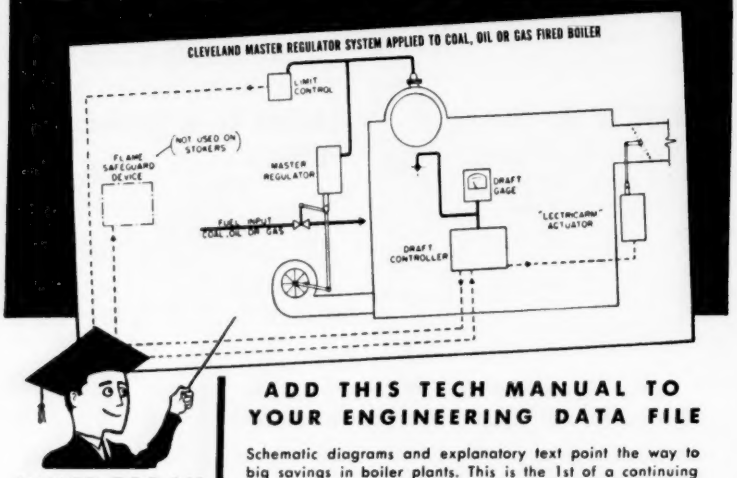

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For more information circle **109** on inquiry card.

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NEW INSTRUMENTS

(can be furnished in other frequencies). It supplies 15 w of undistorted power (less than 1%) through an isolated output transformer. Three impedance taps are provided. Output voltage is continuously variable from 0 to 120.—*Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y.*

For more information circle **284** on inquiry card.

PULSE GENERATOR

New "Type 100B," completely transistorized, incorporates a new standardizer pre-amplifier input; generates

standard 2.5-v system pulses and 25-v variable-amplitude pulses of both polarities, with digitized pulse interval selection. New input standardizer section will trigger on any waveform with a positive risetime of at least 1 usec and 10-v amplitude. Instrument is designed to operate as a general-purpose lab generator, or to provide accurately-timed clock pulses for "Navcor" logic units.—*Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa.*

For more information circle **285** on inquiry card.

ELECTRICAL & ELECTRONIC INSTRUMENTS

PRECISION PHASE METER

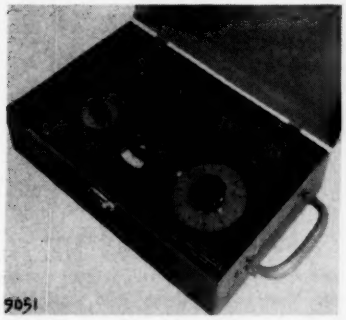
New "Type 405 Series" is said to be "the most stable and convenient device for measuring a phase angle

between two alternating voltages without either amplitude or frequency adjustment." It is perfectly stable for measuring a small fraction of one degree on all ranges including 0-12° range. Other features: (1) reading is independent of ratio of input signal amplitudes; (2) equal accuracy for symmetrical waveforms of any shape; (3) no amplitudes adjustment in both signal voltages; (4) no ambiguity at zero degree; (5) identification of LEAD and LAG; (6) provision for self-calibration and self-adjustment. "Type 405L" has a frequency range from 1 cps to 20 kc, and "Type 405H" from 8 cps to 500 kc.—*Advance Electronics Lab., Inc., 249-59 Terhune Ave., Passaic, N. J.*

For more information circle **286** on inquiry card.

POTENTIOMETER

New "NV-1 High Precision Decade Potentiometer" employs Kelvin-Varley method of voltage division; has



four 10-step dials and an additional two figures can be read on a continuously-variable slide wire. Accuracy is 2 units on last slide-wire dial. Sensitive galvanometer is built-in. Instrument is completely self-contained in an aluminum carrying case. —*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J.*

For more information circle **287** on inquiry card.

DIGITAL VOLTMETER

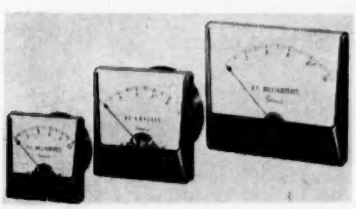
New "Mark IV" in maker's line of dc digital voltmeters is miniaturized and portable (25 lb), is completely

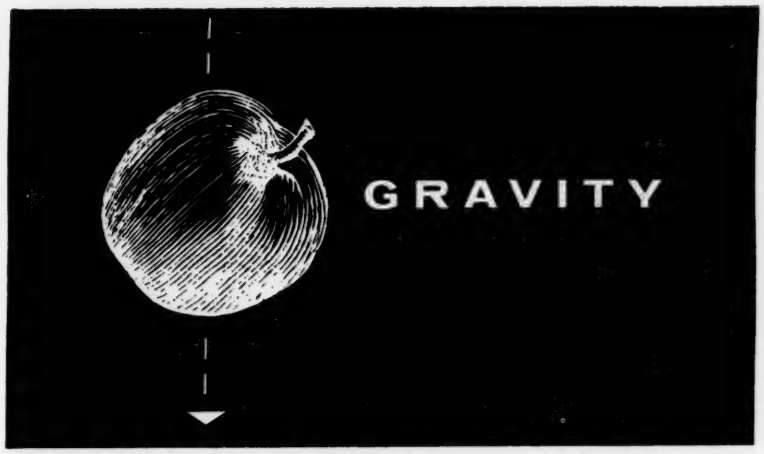
fool-proof; displays 1"-high lighted numerals readable from 30 feet in a well-lighted room. Improved balance logic correctly positions decimal point for maximal number of significant figures under all conditions. Average balance time 1 sec.—*Electro Instruments, Inc., 3794 Rosecrans, San Diego, Calif.*

For more information circle **288** on inquiry card.

RECTANGULAR-PANEL INSTRUMENTS

New "Wide-Vue" instruments feature open-face design and longer scale lengths. For example, 2½" size has same scale length as a conventional

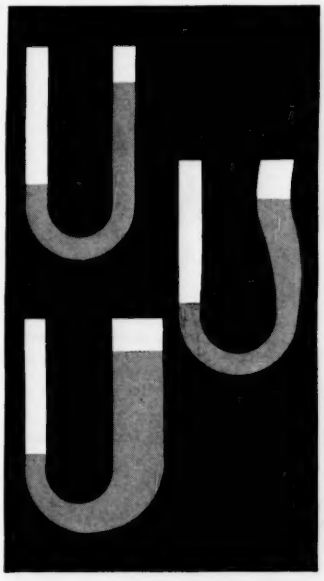




. . . never fails

Accuracy unaffected by tube size or shape

Regardless of any difference in the size or shape of U-Type manometer legs, the *difference* between column heights will always be a true indication of the unknown pressure. More details in Bulletin G-14.



A manometer is operated by the force of gravity. Its perfect reproducible accuracy depends on nothing else. That is why a manometer is always accurate . . . today, tomorrow and forever. Calibration is never required . . . never subject to question.

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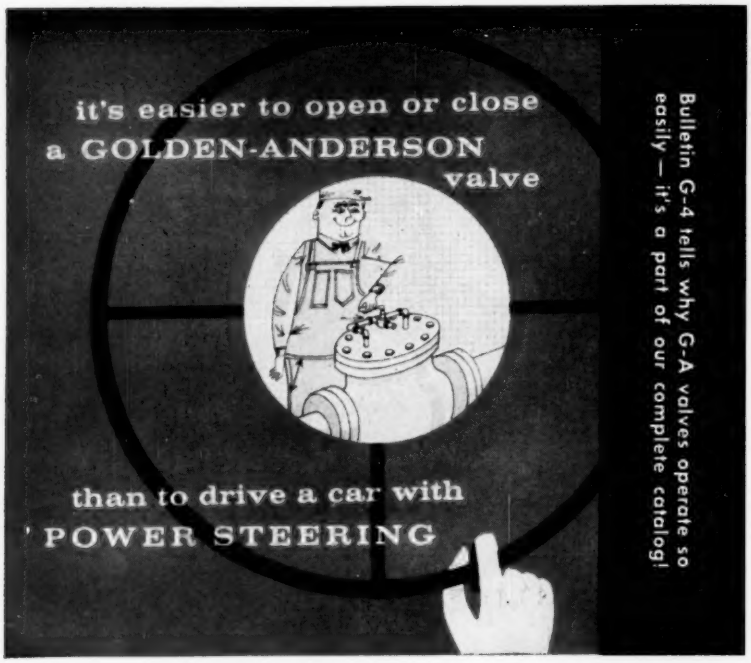
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For more information circle **111** on inquiry card.

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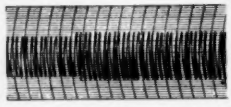
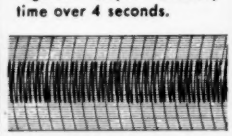
Simultaneous recordings of response to step change in 60 cps voltage.



Typical electromechanical regulator output. Recovery time over 4 seconds.



Curtiss-Wright DEVR output. Full recovery 330 microseconds.

For more information circle **112** on inquiry card.

NEW INSTRUMENTS

3½" panel instrument. Open-faced cover permits wide-angle readability of scales. "Wide-Vue" panel instruments are custom-built in 2½", 3½" and 4½" models with any practical ac or dc range. One-piece plastic cover can be supplied in black or color finishes. Two movements available: maker's standard magnet type, or self-shielded core-magnet movement.—*Simpson Electric Co., 5200 West Kinzie Street, Chicago 44, Ill.*

For more information circle **289** on inquiry card.

AC MILLIVOLTMETER

New portable (5 lb) battery-operated transistorized ac millivoltmeter makes possible measurements down to

50 microvolts. Difficulties due to line voltage fluctuations and 60 cps "beating" are completely eliminated. Twelve full-scale ranges between 0.001 and 300 vac, also decibel coverage between −80 and +52 dbm. Usable frequency coverage from 1 cps to 5 Mc.—*Fisher Research Lab., Inc., Palo Alto, Calif.*

For more information circle **290** on inquiry card.

VACUUM-TUBE VOLTMETER

New "Type 1800-B" combines accuracy of a lab instrument with durability necessary for production line;

features accuracy better than 2% on all ac and dc voltage ranges, completely shielded diode probe designed for use into UHF range, high input impedance, dc polarity switch, illuminated scale with mirror and knife-edge pointer, and all input terminals insulated from panel allowing panel to be grounded at all times.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **291** on inquiry card.

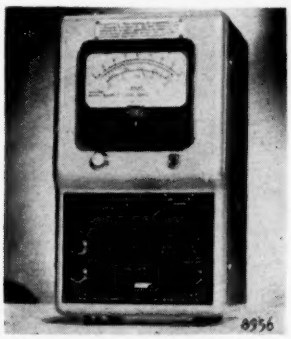
VACUUM-TUBE VOLTMETER

New "Type 405," said to be the first vacuum-tube voltmeter ever to combine 100-mv full-scale sensitivity with dual and differential input features, features a dc performance from 2 mv to 1000 v with 121-meg input resistance; ac performance highly accurate from below 50 cps to ultra-high frequencies. As an ohmmeter, its scale is calibrated from zero to 500 with eight multiplier ranges: ×1 to ×10 meg.—*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

For more information circle **292** on inquiry card.

LOW-FREQUENCY VTVM

New "MV-02B" ac vacuum-tube voltmeter has a frequency range of 2 cps to 250 kc and a full-scale voltage

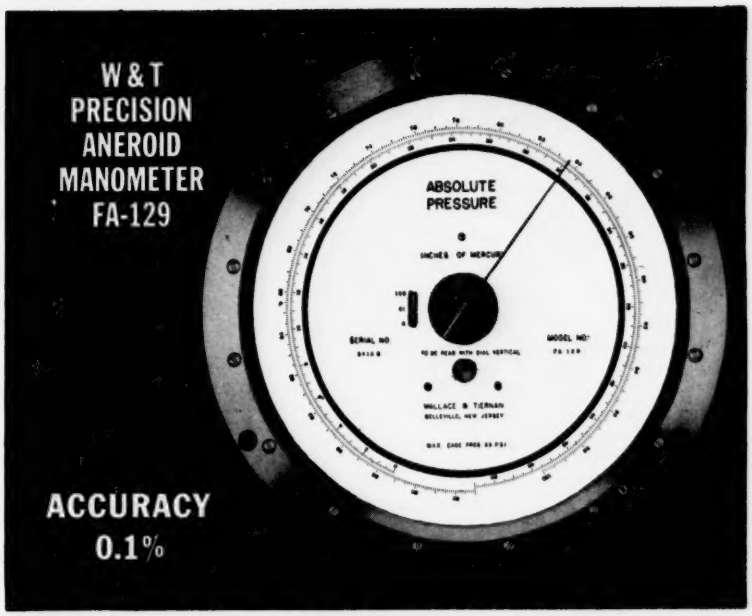


range of 3 mv to 1 kv. Its galvanometer-attenuation switch makes it possible to obtain fast needle response on all measurements above 20 cps while necessary slow response is being maintained between 2 cps and 20 cps. —*Millivac Instrument Corp., P. O. Box 997, Schenectady, N. Y.*

For more information circle **293** on inquiry card.

SENSITIVE OSCILLOSCOPE

New "Type 403" said to be the most sensitive commercially-available 'scope, features full-scale amplitude-



PRECISE CALIBRATING STANDARD
...For Absolute Pressure Work

Ranges: 0 to 31.5 inches of Hg. absolute (min.)
0 to 100 inches of Hg. absolute (max.)
Other intermediate ranges available

Accuracy: 1/1000 of full scale

Sensitivity: 1/10,000 in *all* ranges

Scale Length: 45 inches in two revolutions

Dial Size: 8½ inch diameter

Write for Publication No. TP-15-A

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
In Canada, Wallace & Tiernan, Ltd. — Toronto
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MERCHEN GRAVIMETRIC FEEDERS & METERS

for dry free-flowing materials

- automatic batch control
- continuous blending
- materials accounting

Accuracy 1%
Rates 3 to 3000 lbs. per min.

Write for Bulletin No. M-32

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For more information circle **113** on inquiry card.

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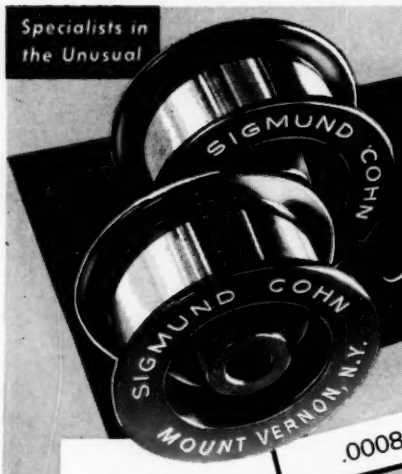

Anodized Aluminum Wire

.0008" TO .030" DIAMETER

HIGH DIELECTRIC COATING

EXCELLENT FLEXIBILITY

To fill a need for high temperature insulation in a high conductivity wire. Precision drawn to close resistance control in the smaller sizes.

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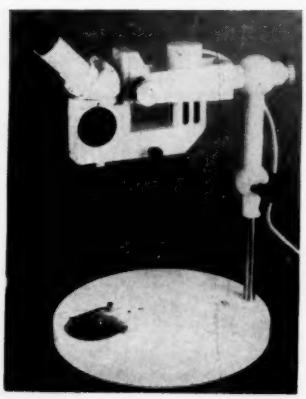
For more information circle **123** on inquiry card.

MADE BY CARL ZEISS IN WEST GERMANY

MICRO TECHNOSCOPE

A stereoscopic binocular microscope eminently suited for industrial inspections and examinations. Intense illumination parallel with line of vision. Erect, plastic image even in deep cavities.

Free working-distance of 8 inches. Magnification changing device provides rapid succession of 6.3x, 10x, 16x, 25x, and 40x magnifications.



Write for literature

CARL ZEISS, INC., 485 5th Ave., New York 17, N. Y.

Guaranteed uninterrupted repair service

For more information circle **124** on inquiry card.

NEW INSTRUMENTS

measuring range of 1 mv to 500 v in 17 steps and can directly indicate microvolt outputs of strain gages, pressure and acceleration pickups, etc., without normally-required preamplification. Frequency response dc to 300 kc. Front panel controls permit selection of 19 accurately calibrated linear sweeps from 0.5 sec/cm to 0.5 usec/cm. Both driven and recurrent sweeps are available with automatic beam-brightening during trace time: on driven-sweep operation, beam is brightened only when sweep is triggered, permitting a camera shutter to be left open without fogging film while awaiting sweep. *Y*-axis amplitude measurement accuracy is better than 5%, includes linearity errors of amplifier, input attenuator, and CRT. *—Allen B. Du Mont Labs., Inc., Clifton, N. J.*

For more information circle **294** on inquiry card.

FREQUENCY STANDARD

New "Model 1400" employs a stabilized tuning fork to generate 400 cps with an accuracy of 0.005% (other

frequencies available). Output voltage continuously variable. Distortion less than 1%.*—Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y.*

For more information circle **295** on inquiry card.

FORTY-BAR-GRAPH 'SCOPE

New "Model DC-40 BG" bar graph oscilloscope provides simultaneous display of forty separate signals. Its 17" CR tube provides a 9" h by 12" w graph comprising 40 vertical lines. Line height is a linear function of signal amplitude; all lines (regardless of height) are terminated with a marking dot at one end and at zero volts at the other for enhanced reading accuracy, which is further enhanced by use of a CRT transparent overlay having 100 evenly-spaced lines (every tenth line double width) and 40 vertical-channel

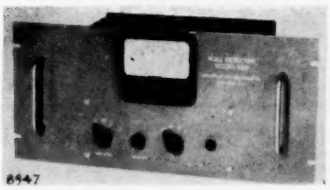
identification lines. Full-scale sensitivity is adjustable from 1 to 10 mv; individual channel attenuators provide 3-to-1 or 5-to-1 change of gain or a small adjustment for compensating input line drop. Scanning rate 400 channels per second; frame rate 10 per second.—*Federal Telephone & Radio Co., 100 Kingsland Rd., Clifton, N. J.*

For more information circle **296** on inquiry card.

ELECTR-INSTRUMENT ACCESSORIES

NULL DETECTOR

New "Model 60B," battery-operated to provide complete isolation from power lines, is well shielded against



external fields and is said to be ideally suited for Schering and other bridges. Sensitivity 3 uv for 1% deflection. Built-in tuned circuits permit a sharp balance even when null is complicated by harmonics.—*Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y.*

For more information circle **297** on inquiry card.

'SCOPE PREAMPLIFIER

New "Type 407 Differential Pre-Amplifier," said to be the first transistorized preamplifier to offer a million-to-one common mode rejection-ratio, is designed for use with any general-purpose 'scope and is said to be ideal for amplifying low-level outputs of strain gages, pressure pickups, etc. It will allow measurement of minute signals which normally would be lost in noise and other extraneous pickup. Completely self-contained, it has flashlight battery life rated at 1,000 hours. —*Allen B. Du Mont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.*

For more information circle **298** on inquiry card.

AMPLIFIER PACKAGE FOR GALVANOMETERS

New "System D" 4-channel galvanometer amplifier package includes power supply; is used with wire strain gages, thermocouples, etc; will drive even low-sensitivity high-frequency galvanometers; provides excellent

Giannini
ROTOSTEPPER

Pulse-to-shaft Position Converter

Powerful, rapid, absolutely controllable shaft rotation in precise 2° increments... for DC pulse-to-analog shaft positioning in computers, sequence switching, algebraic counting, remote shaft positioning.

Pulsed DC from hand operated switches, choppers, or any similar manual or automatic pulsing devices controls the Giannini Rotostepper in precise 2° angles of rotation .... unlimited in either direction, at the rate of one step per pulse.

Optional control mechanisms available on the versatile Rotostepper provide homing to a fixed reference angle, automatic continuous stepping with a steady DC voltage, and/or potentiometric divided voltage functional to shaft position.

SPECIFICATIONS:

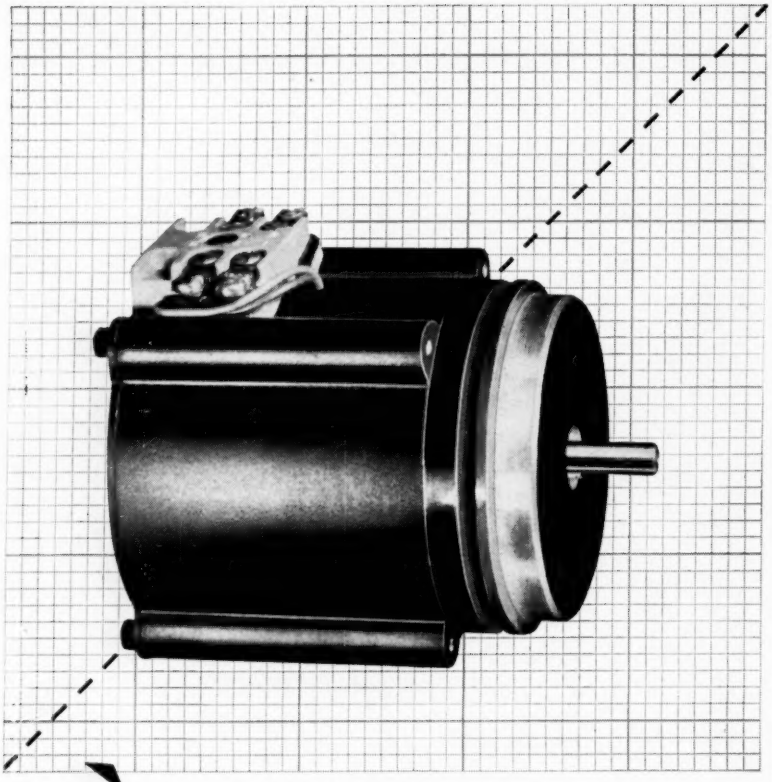
TORQUE: Up to 14 oz-in
SPEED: Up to 60 steps per second
ROTATION: Unlimited CW or CCW in 2° increments
LOCK: Spring detent locks shaft in a position accurate to ±6′
INPUT: 28 volts DC, 10 milliseconds minimum duration per step

Giannini
PRECISION INSTRUMENTS & CONTROLS

For further information write for Rotostepper Bulletin 8915

G. M. GIANNINI & CO., INC., 918 E. GREEN ST., PASADENA, CALIF.

For more information circle **115** on inquiry card.



NEW **DIEHL**

A. C. TACHOMETER

A useful component in servo systems and with linearity accurate enough for use as an integrator in many computing problems.

This tachometer can be furnished separately as shown or mounted integrally with an A.C. Servomotor. Temperature compensated units are also available.

Note these specifications:—

Input	115 volts, 60 cycles
Output	6.0 volts per 1000 RPM
Linearity	± 0.5% above 1000 RPM and ± 0.25% between 50 & 1000 RPM
	Total Residual Voltage — 50. millivolts

A similar unit has been developed for 400 cycle operation.

Send for additional engineering data.

Diehl **DIEHL MANUFACTURING COMPANY**
Electrical Division of THE SINGER MANUFACTURING COMPANY
Finderne Plant, SOMERVILLE, N. J.

other available components: • AC SERVOMOTORS • AC SERVOMOTORS WITH AC TACHOMETERS AC SERVOMOTORS WITH DC TACHOMETERS • AC AND DC TACHOMETERS DC SERVO SETS • RESOLVERS

IA 457.

Booth 1115—I. R. E. Exhibit, Shamrock Hilton Hotel, Houston, Texas, April 11-13, 1957

For more information circle **116** on inquiry card.

NEW INSTRUMENTS

linearity over a wide range of input voltages.—*Allegany Instrument Co., Inc.*, 1091 *Wills Mountain Cumberland, Md.* and 1052 *W. 6th St., Los Angeles* 17, *Calif.*

For more information circle **299** on inquiry card.

AMPLIFIERS

DC-AC MAGNETIC AMPLIFIER

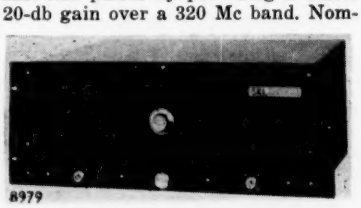
New "No. C-150-223," for self-contained 400 cps input signals, is unique in that it is adaptable to input

signals from dc to 1000 cps with addition of a reference transformer. It requires no vacuum tube or transistor driving stage in a normal servo loop; is designed for use in instrument and computing servo systems; is suitable for driving BuOrd Mk 7 or Mk 8 servomotor or equivalent. Circuit is of full-wave design; external circuitry is minimized through built-in servomotor reference and anti-stickoff voltage for double-speed data systems.—*The Ahrendt Instrument Co.*, 4910 *Calvert Rd., College Park, Md.*

For more information circle **300** on inquiry card.

ULTRAWIDE-BAND AMPLIFIER

New "Model 206 Ultra Wide-Band Amplifier" makes it possible for the first time to faithfully reproduce fast-rise pulses by providing a stable 20-db gain over a 320 Mc band. Nom-

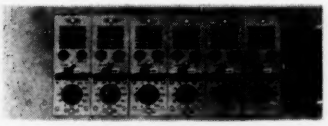


inal gain is 20 db, sloping to 18 db at 300 Mc and 14 db at 320 Mc, but both flat and gradual roll-off characteristics are readily available by means of inexpensive plug-in accessories. Three output modes (linear, pulse and high pulse) are selectable by means of a front panel switch. Integral regulated power supply and rack mounting are also provided.—*Spencer-Kennedy Labs., Inc.*, 1320 *Soldiers Field Road, Boston* 35, *Mass.*

For more information circle **301** on inquiry card.

BROADBAND DC AMPLIFIER

New "Model 111A Broadband DC Amplifier" has a circuit such that with slight modifications its 0 (zero)



gain position becomes an open-loop position. (Normally it has ten gain positions from 0 to 1000). After modification, user can then employ his own feedback networks to provide up to 100% resistive or capacitive feedback around amplifier. By choosing proper input and feedback components, it is possible to select desired gain, cause amplifier to act as an integrator, generate complex linear transfer functions, limit bandwidth, etc. Open-loop dc gain is practically infinite (greater than 140 db).—*Kintel (Kay Lab)*, 5725 *Kearny Villa Road, San Diego* 12, *Calif.*

For more information circle **302** on inquiry card.

POWER SUPPLIES

DC POWER SUPPLY

New "NFAR" dc power supply with a specially designed front panel for rack mounting operates on 115-v

50/60-cps and delivers filtered power with less than 0.75% ripple at top load: 0 to 32v continuously variable for all current loads from 1 to 15 amp.—*Electro Products Labs.*, 4500 *N. Ravenswood Ave., Chicago* 40, *Ill.*

For more information circle **303** on inquiry card.

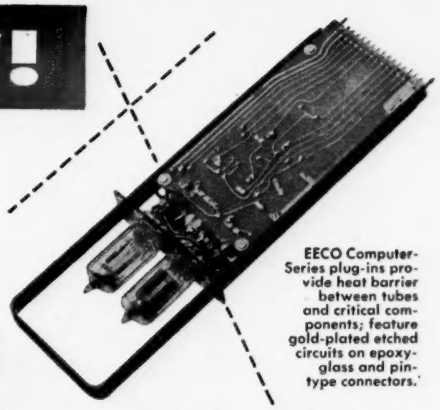
400-CPS VOLTAGE SOURCE

New compact voltage control unit, for testing ac-operated aircraft equipment and components, operates on 115 v 400 cps single phase and delivers 0 to 115 v continuously-adjustable, 15 amp max load. Standard instrumenta-

NEW!

EECO COMPUTER-SERIES PLUG-INS

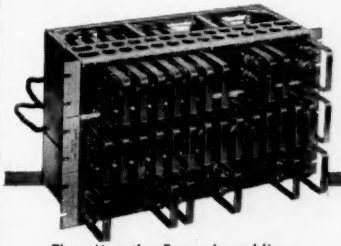
...a refinement of the building-block concept to a degree hitherto unknown, with each circuit a complete off-the-shelf packaged function.



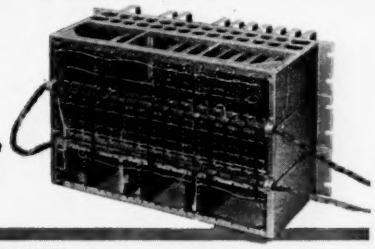
EECO Computer-Series plug-ins provide heat barrier between tubes and critical components; feature gold-plated etched circuits on epoxy-glass and pin-type connectors.

Originally developed for EECO custom systems and proven in critical use, this compatible series of digital and logic circuits is now available to the industry. Meet your project delivery schedules by reducing system-development time to a bare minimum and virtually eliminating drafting and layout time.

PERFORMANCE EECO Computer-Series plug-ins are performance engineered for application where ultra-conservative design at the component level is essential because of system complexity. System prototypes can generally be built directly, without need for the "breadboard" stage.

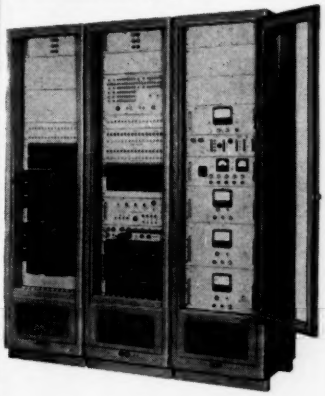


Three Mounting Frame Assemblies were stacked to house this Output Shift Register. Each Mounting Frame accommodates 15 plug-ins, is 3½"x19" for installation in 19" rack.



Rear view of Output Shift Register shows simplicity of point-to-point wiring.

Quick-Look section of EECO-built Project Datum installation at Edwards Air Force Base shows typical modular assembly of Computer-Series plug-ins



***QUICK FACTS:** Tube dissipation de-rated 75%; cathode current de-rated 50%. 1% components used where 5% required and 5% where 10% required. Reliable operation with ±20% change in filament voltage, 30% change in tube transconductance. Isolating diodes on multiple inputs eliminates crosstalk. Low output impedance—in general, cathode follower. (One flip-flop will trigger another at the end of a 50-foot length of twisted pair!) Signal levels clamped. Computer-type tubes. Circuit trouble-shooting already done; layout basically completed. Packaging, heat-barrier, and ventilation problems solved. In-circuit test fixture available.

CIRCUITS You can concentrate on the design of *systems*, knowing you have available a full line of reliable, tested, and proven circuits, including:

Flip-Flops	Quadruple Cathode Followers
Shift Register Elements	One-Digit Adder Matrixes
DC "NOT" Circuits	One-Digit Subtractor Matrixes
Delay Units	One Shots
Pulse Mixer Amplifiers	Neon Drivers

plus 28 Diode Logic Units incorporating "And" and "Or" circuits. In addition, EECO stands ready to design diode logic circuits and produce plug-in units to yield any equation you may require. In short, custom-built logic to order—quickly!

*Detailed information on new Computer-Series plug-ins, as well as on Standard-Series plug-ins, Systems Development Racks, Power Supplies, D-C Amplifiers, and other EECO products is available in Catalog No. 856-A. Write for your copy—today.

ELECTRONIC ENGINEERS AND PHYSICISTS—*EECO offers immediate opportunities for qualified engineers in the transistor, amplifier, data-handling, pulse, timing, and systems-design fields. Send a resume of your qualifications to R. F. Lander, Dept. CS.*

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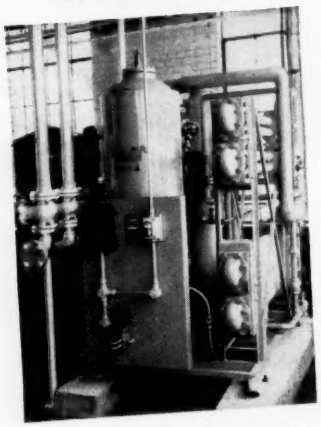
For more information circle **117** on inquiry card.

To: Pete Williams - Plant Supt.
From: Bob Porter
You wanted to know how we keep our instruments and control air lines from fouling up. Here is the answer:

For Efficient LOW-COST Drying of Instrument and Control Air Choose a Pritchard HYDRYER®



Many exclusive features of the Pritchard HYDRYER make it ideal for low-cost drying of instrument air as well as compressed air for air control systems. Features such as:

- NO WASTE—100% of all air entering the HYDRYER is dried without loss.
- FULL LINE PRESSURE REACTIVATION—Pressuring and depressuring of adsorbers between cycles is eliminated.
- NO PURGING—The Type A HYDRYER uses inlet main air stream for reactivation.
- LONGER ADSORBENT LIFE.
- NO MOVING PARTS.
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- REDUCED EQUIPMENT AND LINE SIZES.

. . . and many other proved advantages.

You can get all the facts by writing for Hydryer Bulletin No. 16.0.081. write to

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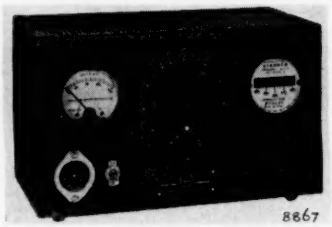
NEW INSTRUMENTS



tion comprises a 21-reed frequency meter and an ac voltmeter.—*Opad Electric Co., 69 Murray St., New York 7, N. Y.*

For more information circle **304** on inquiry card.

REGULATED DC POWER PACKS

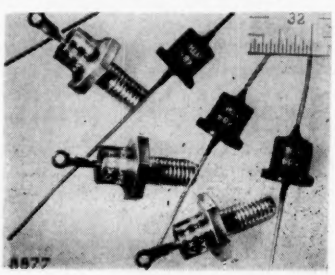
New additions to maker's line of "Transpac" adjustable-voltage semiconductor regulated ac-operated dc power supplies feature high conversion efficiency, low heat dissipation, small size, light weight, no warm-up time, non-microphonic operation, and fast transient response. New units are potted in sealed transformer type housings but transistors are accessible for servicing or replacement purposes. Models are available for 60- or 400-cps 105-125 vac input, output voltage ranges of 5-10, 10-20, 20-30, 30-40, 40-50, 50-55, at current ratings up to 200 ma. Adjustable models are also available for 100-, 150-, 200- and 300-v outputs at 100 ma ratings. Regulation is better than 0.5% for line and load.—*Electronic Research Associates, Inc., 67 E. Centre St., Nutley 10, N. J.*

For more information circle **305** on inquiry card.

RECTIFIERS

SILICON RECTIFIERS

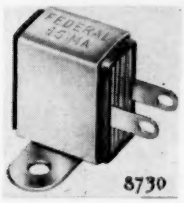
New diffused junction silicon rectifiers available in a 7/16" stud mounted case, and previously announced wire-in types, have forward current ratings increased to 500 ma at 100°C and 250 ma at 150°C (ambient). Six stud types have peak in-



verse voltage ratings in steps of 100 from 100 to 600 v. Forward current rating for all new stud types is 1 amp at 150°C (case temperature).—*Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass.*

For more information circle **306** on inquiry card.

"WRAP-AROUND" RECTIFIER



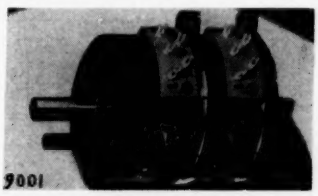
New type of 65-mil selenium rectifier with a metal "wrap-around" design is said to offer major advantages over conventional equivalent-rating selenium rectifier designs. Its individual cells are placed flat against one another like pages in a book. Center mounting shafts, with associated nuts and washers, are eliminated. Metal "wrap-around" provides thermal coupling to chassis which acts as a heat sink, so that air cooling is not necessary. Elimination of center hole gives each cell a larger effective area and therefore a greater current safety factor. Addition of a seventh cell provides an additional safety factor.—*Federal Telephone & Radio Co., 100 Kingsland Rd., Clifton, N. J.*

For more information circle **307** on inquiry card.

ELECTRICAL COMPONENTS

NONLINEAR VDRs

New nonlinear precision wirewound "Acepot" voltage-dividing resistors are available in standard and

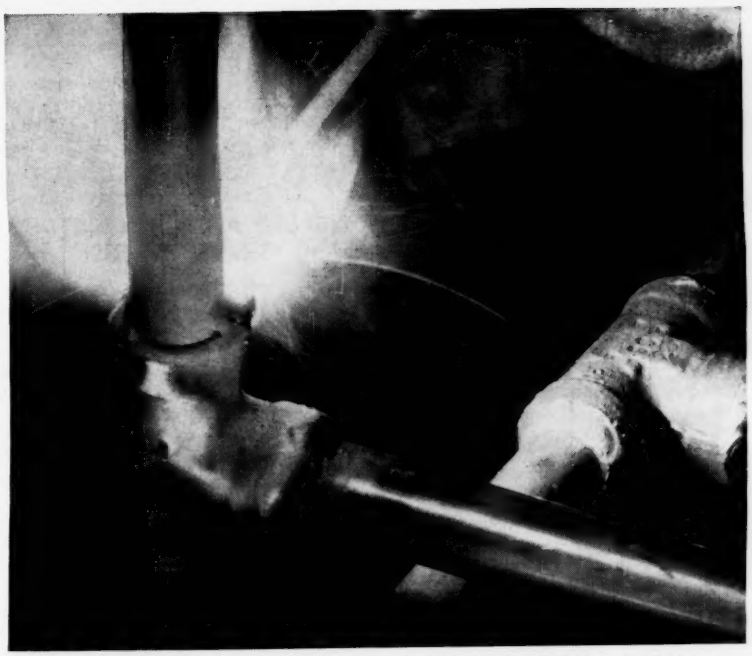


sub-miniature sizes, in prototype and production quantities, from maker's new Nonlinear Department. Standard sine-cosine units are available in AIA sizes 30 and 20 with tolerances of 0.5% and 1.0% peak-to-peak respectively; standard square-law units in AIA sizes 30 and 20 with tolerances of 0.25% and 0.75% independent conformity respectively.—*Ace Electronics Associates, Inc., 103 Dover St., Somerville 44, Mass.*

For more information circle **308** on inquiry card.

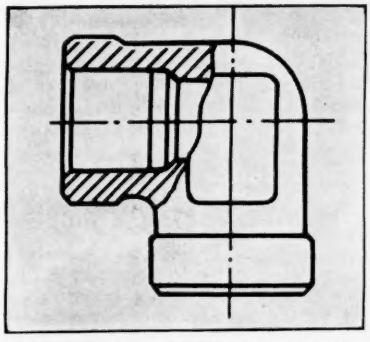
METAL-FILM RESISTORS

New additions to maker's line of "Vamistors" (precision metal film resistors) extend availability of resistance values up through 1 megohm. Units have resistance alloy fused into inner surface of a moisture-sealed ceramic tube in a dispersed form which renders unit virtually imper-

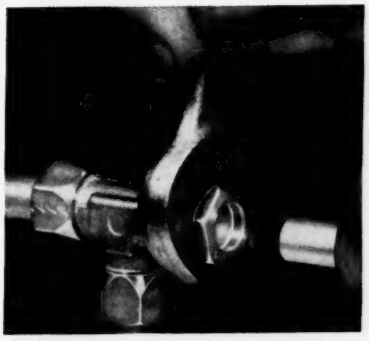


Simply insert tube, then weld! No wonder Parker Weld-lok *tube* fittings are so easy to use . . . by anyone, anywhere. You don't need special gripping fixtures. A tapered socket aligns and holds the tube. The permanently welded joint is unaffected by vibration, shock, or thermal distortion. Especially good under extreme temperature or corrosion conditions.

Use Parker Weld-lok fittings for tubing ¼ through 2" O.D.



Cutaway view of Weld-lok *tube* fitting shows detail of the simple design. All commonly used connectors and body shapes are offered in steel and stainless steel. Send for Catalog 4370 listing shapes, sizes.



Intru-lok fittings are easy to use for copper instrumentation lines. Just insert the tube, then tighten the nut with a regular wrench . . . for a leakproof vibration-proof joint. Also used with plastic tubing. Send for Catalog 4324.

TUBE AND HOSE FITTINGS DIVISION
Section 424-K
The Parker Appliance Company, 17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid system components

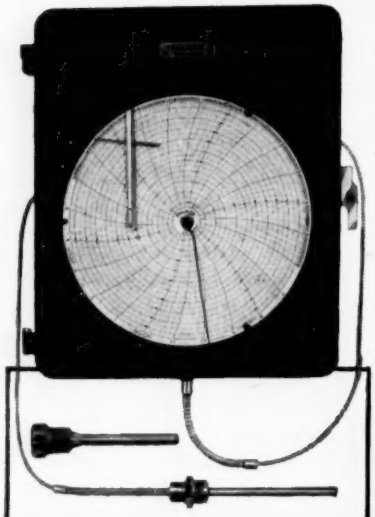
For more information circle **119** on inquiry card.

PALMER

MERCURY ACTUATED

recorders

Into this modern Mercury Actuated Recorder has gone all the skill of Palmer master craftsmen.



Readings are clearer, smoother and more precise than ever thought possible. In fact readings are so amazingly improved that maintenance is never needed under normal uses.

Recording Thermometers feature twelve inch die-cast aluminum case with black wrinkle or white satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 to 1000°F, or Equivalent in °C.

Send for Bulletin No. 45

Consult your Classified Directory

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

Cincinnati 12, O.

For more information circle **314** on inquiry card.

vious to effects of abrasion, thermal shock and temporary overloads.—*Weston Electrical Instrument Corp., Newark* 12, *N. J.*

For more information circle **309** on inquiry card.

MOLDED PLUG-IN MINIATURE TRANSFORMERS

New epoxy-molded plug-in, printed-circuit miniature transformers, available in a wide range of electrical ratings; MIL-T-27A, Grades 2 and 5.—*Microtran Co., Inc.*, 145 *E. Mineola Ave., Valley Stream, N. Y.*

For more information circle **310** on inquiry card.

CONTROL RESISTOR

New "Model R Variable Composition Control" for "RV4" style under MIL R-94A features a unique design: A molded composition resistance track, a radial resistance element filling entire inner perimeter

of resistor barrel. Among advantages over old axial style: wattage dissipation is higher and localized hot spots are reduced. Available in 3-watt standard rating; 2 watts under RV4 style; rotational life 100,000 cycles (guaranteed). Linear and modified clockwise and counterclockwise tapers.—*Reon Resistor Corp.*, 117 *Stanley Ave., Yonkers, N. Y.*

For more information circle **311** on inquiry card.

ELECTRONIC COMPONENTS

MINIATURE QUARTZ CRYSTAL

New "Type BG 6 A" vacuum-mounted quartz crystal unit features an AT-cut element produced with newly-developed process techniques which minimize aging and maximize reliability. Tolerance is 0.0005% of nominal frequency at 25°C; stability is 0.0015% maximum deviation from measured frequency at 25°C over ambient range from −55°C to 90°C; aging is 2 PPM maximum during first year of service under low drive conditions.—*Bliley Electric Co., Union Station Bldg., Erie, Penna.*

For more information circle **312** on inquiry card.

HIGH-CONDUCTANCE DIODE

New "Type DR385" very-high-conductance gold-bonded germanium diode features controlled voltage drop: at 10 ma, voltage drop is controlled between 0.34 and 0.37. Reserve characteristic; at 10 v, one megohm, with a peak inverse voltage of 60. Fast transient response. Units can be offered fully-tested to individual recovery conditions.—*Radio Receptor Co., Inc.*, 240 *Wythe Avenue, Brooklyn* 11, *N. Y.*

For more information circle **313** on inquiry card.

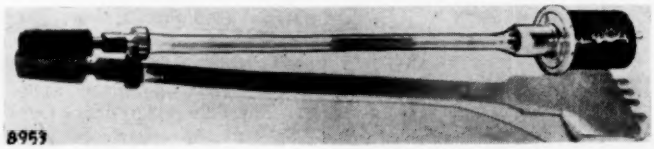
FERRITE ISOLATOR

New "Model W177-2C-1" stock ferrite isolator for laboratory and test bench use, involving a new resonance

technique, is 2½" long, weighs 1½ lb; is designed for maximum frequency stability; is usable from 8.2 to 10.2 kMc; has high isolation (minimum of 25 db over band) and less than 1 db insertion loss.—*Kearfott Co., Inc., Microwave Dept., Western Div.*, 14844 *Oxnard St., Van Nuys, Calif.*

For more information circle **314** on inquiry card.

LONG-LIFE TRAVELING-WAVE TUBES

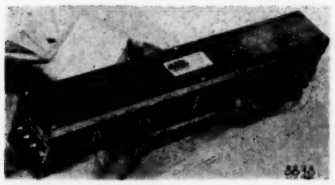


New traveling-wave tubes for 2000-Mc and 4000-Mc bands feature life of 10,000 hours or more at reasonable cost. Complete range is available. Examples: "Type N1001" is a power tube rated at 16 w; "N1002" has a noise factor of 10 db and a gain of 25 db; "N1013" has a 35-db gain and 200 mw output.—*Marconi Instruments*, 44 *New Street, New York* 4, *N. Y.*

For more information circle **341** on inquiry card.

DELAY LINE

New "Type 4D92" lumped-parameter delay line, with total delay of 300±1% usec, has taps available at

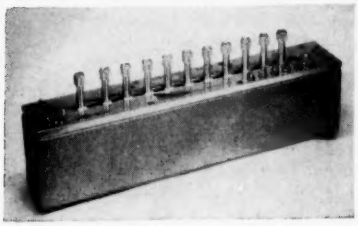


every 1-usec or any multiple thereof; maximum attenuation 4 db and delay-to-rise-time ratio 75 to 1 over entire length. Maximum rise time 4 usec; impedance 1000 ±5% ohms.—*Underwood Corp., Electronic Computer Div., 35-10 36th Ave., Long Island City 6, N. Y.*

For more information circle **315** on inquiry card.

MAGNETOSTRICTION-TYPE DELAY LINE

New "Model 103-10" is a modified "Model 103" delay line with ten pick-up coils instead of previous four; has

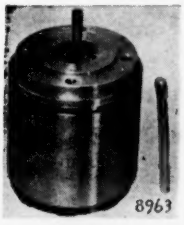


a range of 2 to 40 usec; provides for ten continuously-adjustable outputs; utilizes magnetostriction principle with a nickel element; is 12" long.—*Deltime, Inc., 608 Fayette Ave., Mamaroneck, N. Y.*

For more information circle **316** on inquiry card.

ELECTROMECHANICAL COMPONENTS

HIGH-TORQUE SERVOMOTOR



New "Type 15-5156-03" size 15 115-v 60-cps two-phase servo motor weighs 7.6 oz but delivers 1.45 oz-in minimum stall torque. Phase 1 is 115 v and phase 2 115/57.5 v. Speed is 3200 rpm at no load. At stall, current is 0.06 amp per phase and power 6.1 w per phase.—*John Oster Mfg. Co., Avionic Div., Racine, Wis.*

For more information circle **317** on inquiry card.

LIGHT-WEIGHT MOTORS

New line of light-weight high-performance induction motors for aircraft application where size, weight,

AT LARGE MIDWESTERN MANUFACTURING PLANT*

Diamond INDUSTRIAL TV

Fire-Watches 29 Acres of Roof

Saves $20,000 PER YEAR

Viewing Screens in basement guardroom enable guard to watch the roof easily and comfortably in addition to other duties.

Two tower-mounted Diamond ITV Cameras automatically sweep back and forth watching the 29 acres of roof. This installation has been in continuous operation since September, 1955.

Remotely controlled zoom lenses . . . remote control to stop, start or angle either camera, enables the guard to take a close look at anything suspicious. Remotely controlled windshield wipers on weatherproof camera housings keep viewing windows clear in bad weather. Fire hasn't a chance to get a serious start.

Savings in guard wages amount to $20,000 per year . . . will more than pay for the installation in a year. Lonely and sometimes unpleasant jobs are eliminated. Have you explored the money saving resources of Diamond ITV? Call your Graybar Distributor, or use the coupon below.

*Name on request.

7729

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Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

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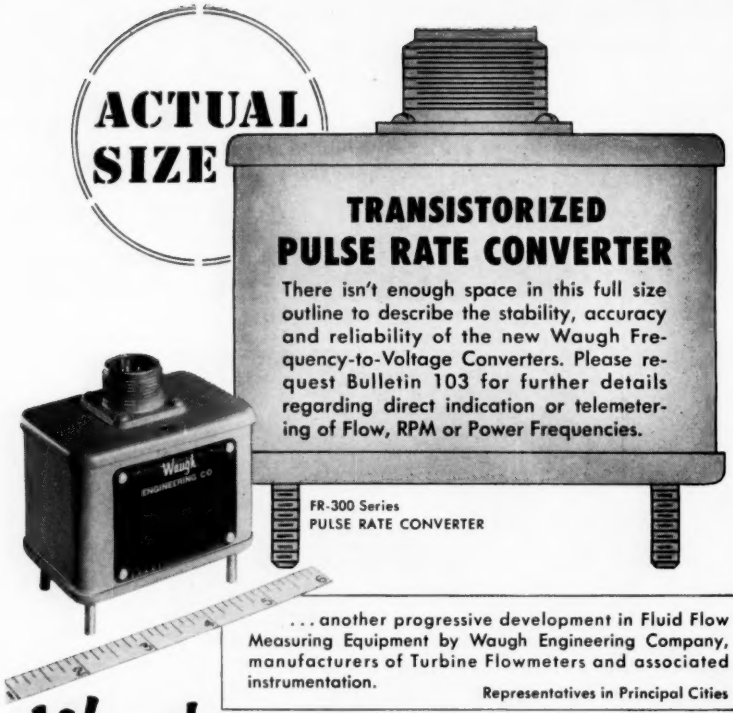
Company_____

Address_____

For more information circle **122** on inquiry card.


ACTUAL SIZE
TRANSISTORIZED
PULSE RATE CONVERTER
There isn't enough space in this full size outline to describe the stability, accuracy and reliability of the new Waugh Frequency-to-Voltage Converters. Please request Bulletin 103 for further details regarding direct indication or telemetering of Flow, RPM or Power Frequencies.
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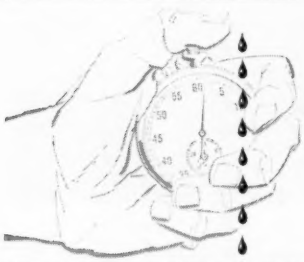
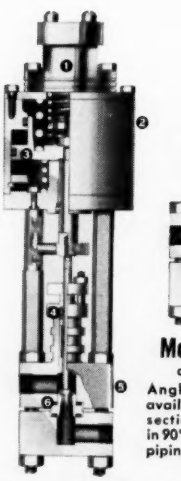
For more information circle **120** on inquiry card.



Split second action ...small flow control ...at 6,000 psi

New achievement by Annin in high pressure control and precise valve response for Research—Development—Process applications

Annin's new Model 9460, designed for working pressures to 6,000 psi, provides research, pilot plant and process control engineers with an extremely responsive small flow control valve suitable for low capacity systems. The operator will fully stroke in either direction in 0.75 seconds or less. New design features include: ❶ integral positioner, open-on-air-failure or close-on-air-failure action; ❷ Annin's 600 Series Domotor operator; ❸ differential area piston, eliminating need for loading regulator; ❹ universal stuffing box for —400°F to 750°F; ❺ offset globe or angle body design; ❻ valve plug stem and seat ring common to both globe and angle bodies. For reliable fluid control and flexibility of application Annin offers the **best source** for solving any small flow control problem.



Model 9461
angle body

Angle bodies are available with body sections rotatable in 90° increments for piping convenience.

YOURS FOR THE ASKING—Complete information and specifications are contained in Bulletin No. 9400. Write for your copy today.

THE ANNIN COMPANY **ANNIN** *Control* **VALVES**
DIVISION OF THE ANNIN CORPORATION
6570 Telegraph Road, Los Angeles 22, Calif.

For more information circle **121** on inquiry card.

NEW INSTRUMENTS

and temperature are critical limiting factors, are said to provide, with no reduction of efficiency or power factor, "the lowest motor weight to power ratios in the aircraft field, frequently lower than 1 lb per hp. Standard or custom models, for power outputs from 10 watts to 1000 hp; can be provided to operate from standard, special, or variable frequency power supplies. Characteristics can be tailored as regards speed, torque, efficiency, current, and motor proportion.—*Task Corporation*, 1009 *East Vermont Ave., Anaheim, Calif.*

For more information circle **318** on inquiry card.

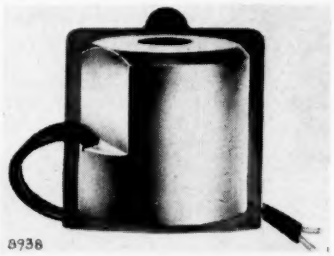
MINIATURE AC MOTORS

New "Type FC" motors for 115 or 200 vac, 60 or 400 cps, suit applications where size, weight, performance, and maximum reliability are important. Frame size is 1.675" dia and up to 4.5" long. Motors are wound for single-phase (with a capacitor) or 2-phase operation; 2-, 4- or 6-pole; and 3-phase, 2- and 4-pole; can be furnished with integral planetary gear reducers, offering 102 ratios between 4 to 1 and 3 million to 1. By varying speed of basic motor, 306 standard output speeds are available. For gear reduced motors, induction rotors produce up to 3.5 oz-in of torque; hysteresis rotors, operating at synchronous speed, produce up to 1.2 oz-in of torque. Characteristics of these motors can be readily varied to suit application requirements. "FC" motors can be protected to meet military environmental specifications if desired. —*Globe Industries, Inc.*, 1784 *Stanley Ave., Dayton, Ohio.*

For more information circle **319** on inquiry card.

EN-BLOC SOLENOID COIL

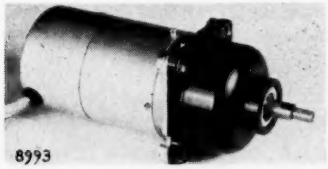
New "Kast-Coil," solenoid-coil assembly processed with epoxy resin under vacuum and cured electronically, features a void-free high-density casting; provides high resistance to thermal shock and physical abuse; is impervious to corrosive fumes; is reported to be "designed to last forever"; carries an "unconditional guarantee."—*Dept. No. 406-A, Hays Mfg. Co., West 12th St., Erie, Penna.*



For more information circle **320** on inquiry card.

GEARHEAD MOTOR

New miniature gear head motor operates on 115±5 vdc; output speed 12.5 rpm ±25%; gear drain is 100

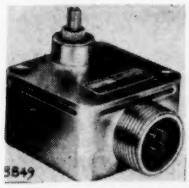


ma. Motor is designed for intermittent duty and is reversible; conforms to MIL-M-8609 (ASG) and missile purchase description MPD-401.—*Western Gear Corp., Electro Products Div., 132 W. Colorado St., Pasadena 1, Calif.*

For more information circle **321** on inquiry card.

SWITCHES, etc.

MINIATURE LIMIT SWITCH



New hermetically-sealed "#9135" limit switch has a 360° rotary action with 180° pretravel, 180° overtravel; is available in two models for different applications; comes with potted leads or pin connectors; can be mounted flat with four fasteners or mounted vertically behind a retainer with washer and lock nut. It operates at 28 vdc or 110 vdc with 10 amp resistive rating, 4 amp inductive. At 110 vac or 220 vac resistive rating is 10 amp.—*Haydon Switch Inc., Waterbury 20, Conn.*

For more information circle **322** on inquiry card.

SWITCH ACTUATORS

New roller, leaf and push button actuators for "Klixon KX4 Sine Switches" increases utility of basic

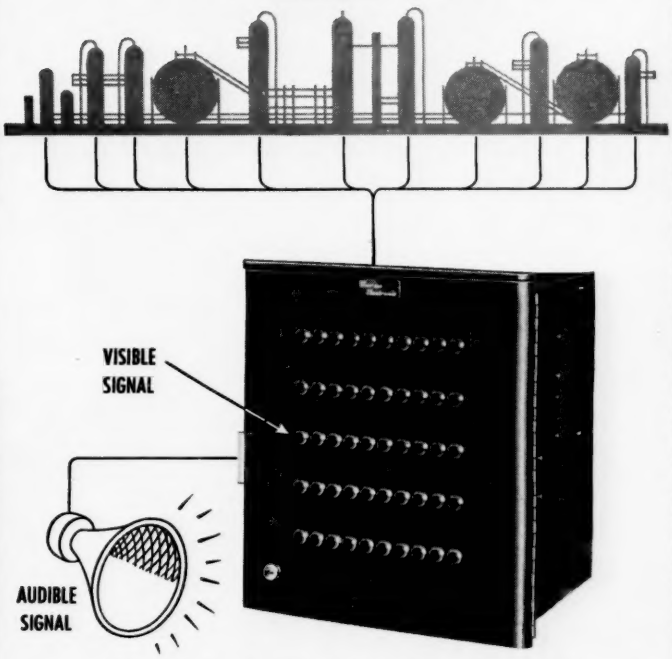
switch and considerably widens its range of application. All auxiliary actuators provide additional overtravel; are of stainless steel construction; include rugged positive stops and long-life torsional springs.—*Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.*

For more information circle **323** on inquiry card.

OIL-TIGHT PUSHBUTTONS

Two new oil-tight pushbuttons: "Roto-Push" operator unit combines functions of a single-button station with advantages of a 2- or 3-position selector switch in one unit. Contacts are maintained or momentarily operated by either turning guard ring, de-

Monitor Critical Temperatures From MANY Points



With T-E Temperature Monitoring Systems

For dependable, close checking of many temperatures—T-E offers you a completely integrated, flexible system designed for your exact monitoring needs. It can be located near to or remote from the process area and can monitor almost any number of points—up to several hundred in one system. Ideal for all process operations, it also helps reduce down-time by quickly warning of any overheated condition. Dangerous temperatures are indicated by both audible and visible signals.

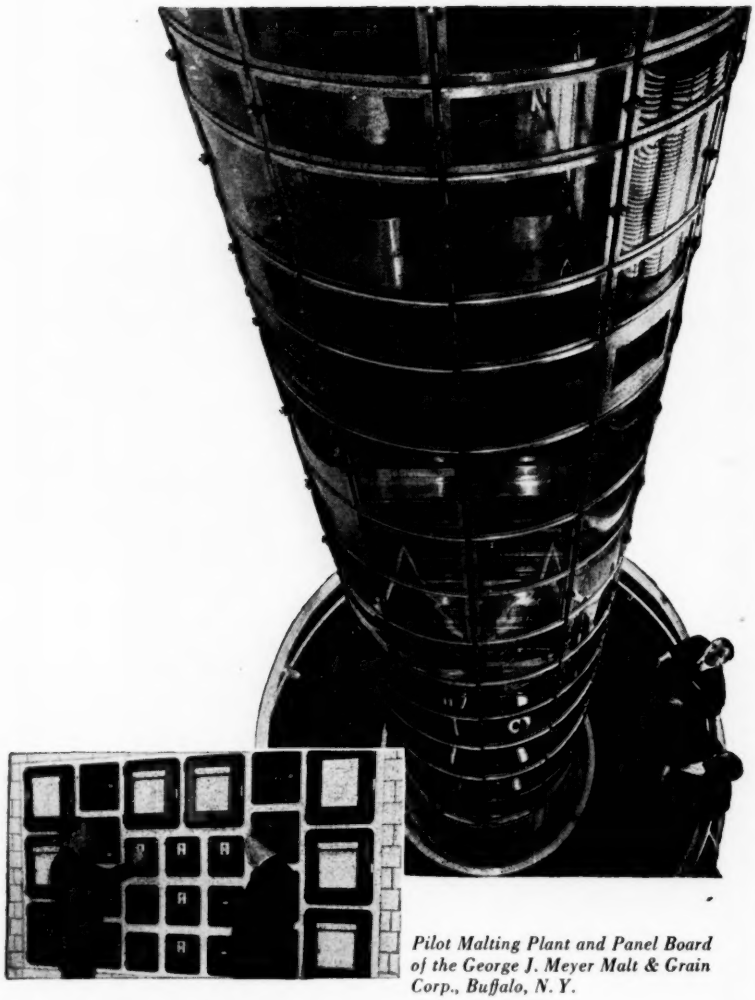
- **Continuous scanning**
- **Available with single or multiple set points**
- **Monitors temperatures from —320° F. to +3000° F.**
- **Functions with thermocouples or resistance bulbs**
- **Signals may be transferred to indicators or recorders**

Switching Speeds Standard—3 seconds per point. Others as fast as 2.5 points per second or as slow as 6.6 seconds per point.

Write for Bulletin 72-F.

Thermo Electric Co., Inc.
SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ontario

For more information circle **125** on inquiry card.



Pilot Malting Plant and Panel Board of the George J. Meyer Malt & Grain Corp., Buffalo, N. Y.

Important data for malting research recorded on TECHNICAL CHARTS!

This tower-like pilot malting plant is completely automatic, with more than 50 miniature valves, gates, dampers and similar devices. During research on the 10 day cycle of converting barley to malt, variables of temperature and moisture are accurately recorded at 42 points on TECHNICAL strip charts.

Research scientists as well as production engineers the country over rely on the accuracy found in every TECHNICAL chart. They also appreciate TECHNICAL'S ability to supply charts for **all** their instruments, regardless of "make". If you are not already a user, join the thousands who are by specifying TECHNICAL.

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For more information circle **126** on inquiry card.

NEW INSTRUMENTS

pressing button, or a combination of both. "Pres-Test" indicating light provides a simple means of checking indicating lights without disturbing con-

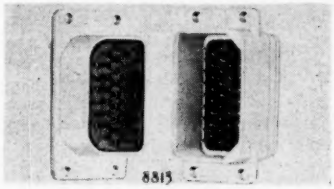
trol circuit and without removing a lens or bulb. All C-H oil-tight pushbuttons have back-of-panel depth of only $1\frac{23}{32}$" for transformer types and $1\frac{7}{8}$" for resistor units; are available in key-operated, selector switch, flush button, mushroom head or knob-operated models.—*Cutler-Hammer, Inc., 503 N. 12th St., Milwaukee, Wis.*

For more information circle **324** on inquiry card.

CONNECTORS, etc.

RACK AND PANEL CONNECTOR

New "SR Type" rack and panel electrical connector incorporates a solid shell and resilient insert to facil-



itate pressurization and to give maximal protection against vibration. Other features: low contact engagement forces; closed entry sockets; heavily gold-plated contacts; cadmium plated clear irridite finish; operating temperature range −67°F to 250° F. Insert patterns will be available to mate with equipment now in service.—*Bendix Aviation Corp., Scintilla Div., Sidney, N. Y.*

For more information circle **325** on inquiry card.

MINIATURE CONNECTORS

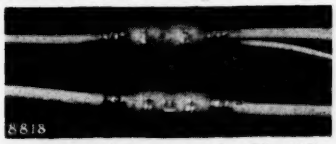
New "Pygmy Connectors" are miniature aluminum aircraft connectors weighing less and taking less space than standard AN connectors (in certain shell styles, 25% size and weight of standards). Contacts are size 20, heavily gold-plated, featuring machine-closed entry sockets. Choice of quick-disconnect coupling: modified double stud thread or 3-point bayonet

lock. Provisions available for grommet sealing, potting, cable sealing, conduit applications. Wide variety of shell sizes, styles and insert arrangements.—*Avnet Eastern Sales, 36 N. Moore St., New York City* 13, or *Avnet Western Sales, 8966 National Blvd., Los Angeles* 34, *Calif.*

For more information circle **326** on inquiry card.

INSULATED SPLICE

New "Sealink" permanent water-sealed and insulated splice accommodates AN wire sizes #26 thru #10;



is color-coded for easy size identification. Used as either a two-wire water-sealed splice, or for multi-wire applications (see photo), it meets MIL specs. It comprises a highly conductive electro-tinned copper link, a transparent nylon insulation sleeve, and anodized aluminum sealing rings; is installed with a ratchet-type controlled-depth-of-indent "Hytool."—*Burndy Corp., Norwalk, Conn.*

For more information circle **327** on inquiry card.

MECHANICAL COMPONENTS

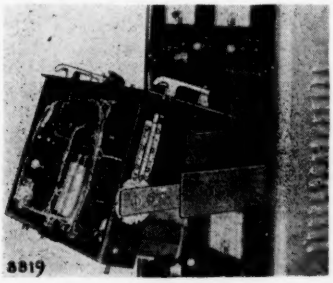
SERVO COMPONENT MOUNTING PLATES

New "Type AT," made of 24ST aluminum with a anodized finish are designed for horizontal and vertical mounting, are especially applicable for mounting many "famous-make" components.—*PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.*

For more information circle **328** on inquiry card.

CABINET ROLLER SLIDES

New roller slides allow chassis to glide out at a touch on stainless steel rollers, and to be tilted up and down for fast servicing of both tube and circuitry sections. Three models: "De-



Servo Engineers Work where your

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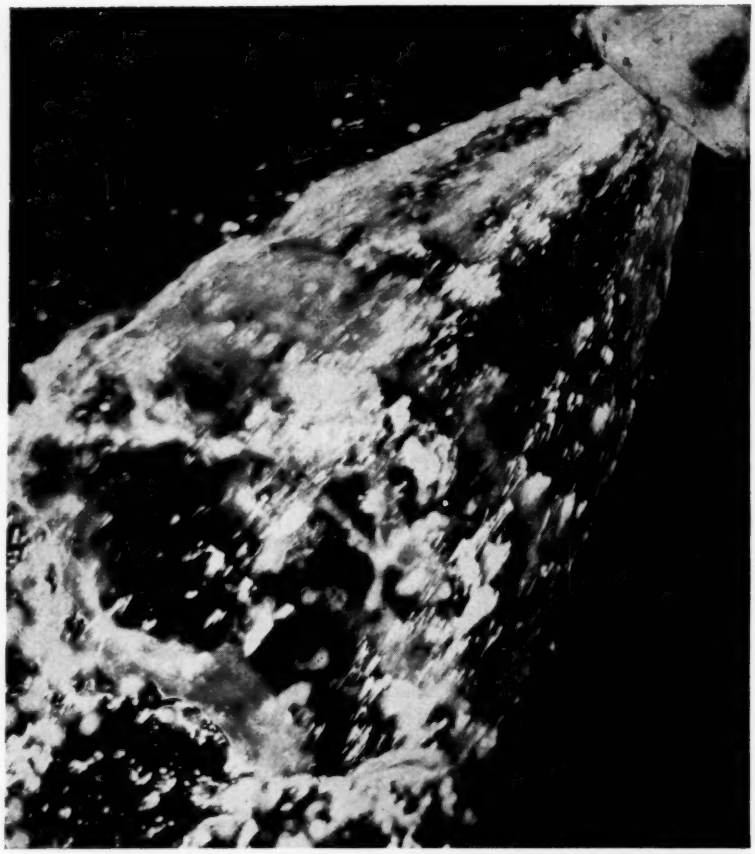

To show fluid volume, photographer Bernard Hoffman uses the free discharge of water from an ordinary garden hose.

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NEW INSTRUMENTS

tent," for mobile installations or above eye level, tilt-locks in seven different up-down positions. "Basic," for stationary installations, tilts back for servicing. "Cradle Track" is a prealigned assembly for fast installation in either cabinets or racks. Eight stock lengths for 17" wide chassis.—*Chassis-Trak, Inc., 525 S. Webster St., Indianapolis, Indiana.*

For more information circle **329** on inquiry card.

DRIVE ADAPTERS

Two new flexible shaft drive adapters: (1) New T Adapter for use where space and weight are factors

and where high speed and heavy torque are required. (2) New Reverse Rotation Adapter transfers power while reversing direction rotation of flexible shaft. Both are compact and light weight, housing being of aluminum alloy; both are furnished in unity gear ratio.—*F. W. Stewart Corp., 4311 Ravenswood Ave., Chicago 13, Ill.*

For more information circle **330** on inquiry card.

SPEED REDUCER KITS

New "U4" and "U5" speed reducer kits are designed for reuse, allowing assembly and disassembly to com-

8875

ponent hangers as desired with a complete range of ratios. "U4" is 1¾" OD and "U5" 1-1/16" OD. Both have six speed reducers and an additional 31 component parts. Immediate delivery. —*Pic Design Corp., 477 Atlantic Ave., East Rockaway, N. Y.*

For more information circle **331** on inquiry card.

COUPLING KITS

New "T7," "T8" and "T9" kits contain each: 9 couplings and 15 associated components in a felt-lined case. Shaft sizes ¼", ⅜" and ½".—*PIC Design Corp., 477 Atlantic Ave., East Rockaway, N. Y.*

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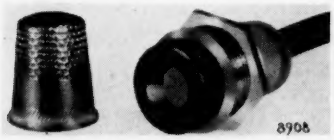
PHOTOCELLS

SUBMINIATURE PHOTOCELL

New "Model 6350" is self-generating, permitting simplification of circuitry. Its output is proportional to



light intensity and loading. Typical input-output proportions are 300 mv at 100 foot-candles into 1 megohm, or 20 microamp at 100 fc into 100 ohms. —*Autron Engineering, Inc.*, 1254 *W. Sixth St., Los Angeles* 17, *Calif.*

For more information circle **333** on inquiry card.

PHOTOCELL

New "Powermaster," said to have "more power-controlling ability and sensitivity than any other on the

market today," will directly operate ac or dc relays, also electronic trigger circuits at 1000 counts per second; acts as a non-polar variable resistor; lowest-sensitivity unit will pass 10 ma at 22.5 v at 50 ft-candles (higher sensitivities available); dark resistance over 1 meg.—*Hupp Electronics Co.*, 743 *Circle Ave., Forest Park, Ill.*

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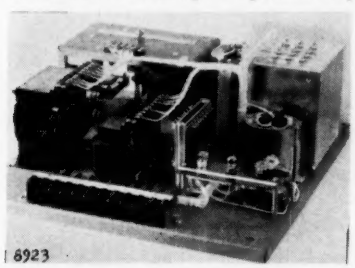
MISCELLANEOUS

ALTERNATOR CONTROLLER

New "Magohm Type STR" transistor-magnetic amplifier regulator will control virtually all present-day



exciter-excited 400-cps generators; will regulate at 120, 208, or 440 volts, over a range of 380 to 420 cps; usually supplied with three-phase sensing, but also offered with single-phase sensing. Alternator output voltage will stay within 0.5% for all steady-state load conditions over entire frequency band. Regulator's four elements—generator, voltage detector, voltage reference, transistor-magnetic amplifier and

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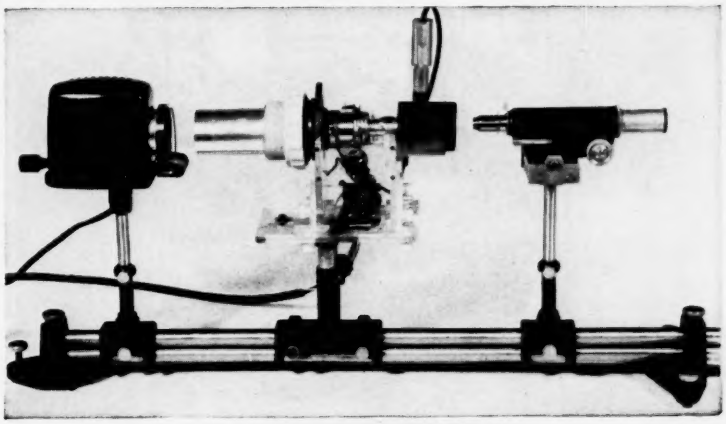

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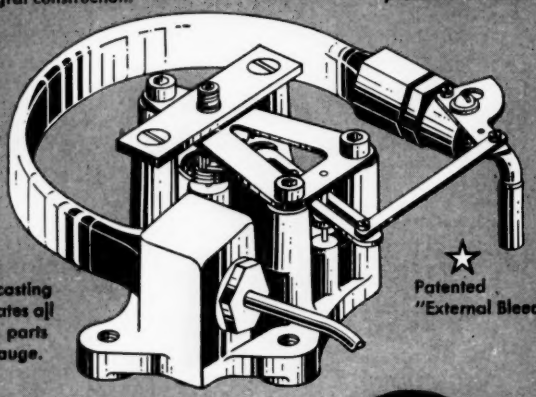

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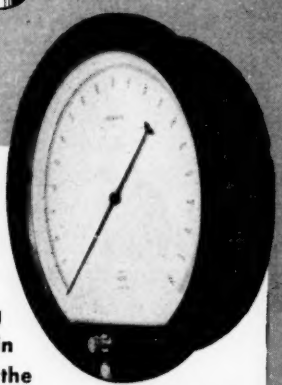

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For more information circle **130** on inquiry card.

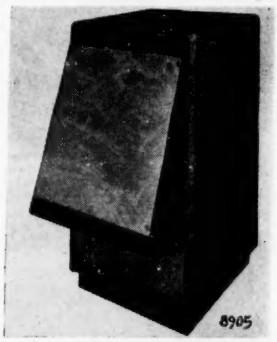
NEW INSTRUMENTS

stabilizing network—operate at the most conservative ratings, assuring dependable performance and long life. —*Electric Regulator Corp. Norwalk, Conn.*

For more information circle **335** on inquiry card.

DEEP 'SCOPE ENCLOSURE

New "Model F3IDS" modular enclosure, designed to accommodate many of the largest oscilloscopes on

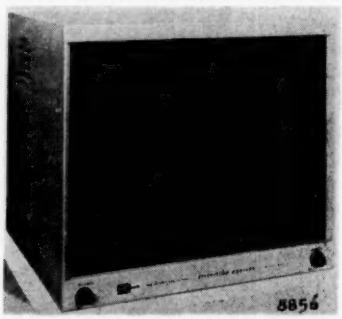


the market today, comprises a standard frame (F31) and a turret (FT21) with a panel opening 21" high and a slope of 20°; is 40" high with a minimum depth of 25" at top and a maximum depth of 32" at bottom of face. Maximum chassis clearance 17¾".—*Amco Engineering Co., 7333 W. Ainslie St., Chicago 31, Ill.*

For more information circle **336** on inquiry card.

21" ITV MONITOR

New "Model ARM-21" is a 21" video monitor designed to provide continuous remote viewing of video infor-



mation from industrial or broadcast TV camera chains. It can be positioned up to 1000 ft from camera control unit without line amplifiers, and up to 4000 ft with line amplifiers.—*Kintel (Kay Lab), 5725 Kearny Villa Road, San Diego 12, Calif.*

For more information circle **337** on inquiry card.

OUTDOOR RECEPTACLES

New safelock receptacles, in cast condulet housings suitable for all outdoor weatherproof service, are designed with many improved safety features for extension cord sets for lamps, tools, etc. To prevent fire or

explosions (or accidental removal of extension cord) cord set caps are securely locked in position and cannot be removed until release lever is manually tripped, which, in turn, automatically deenergizes sockets.—*Industrial Automation Corp., 2415 W. Montrose Ave., Chicago, Ill.*

For more information circle **338** on inquiry card.

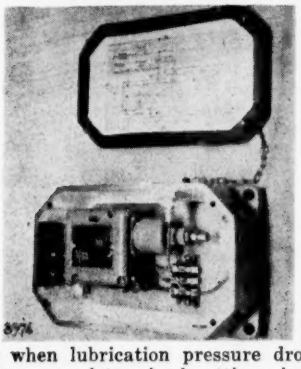
TELEPRINTER RELAY ELIMINATOR PACKAGE

New "Model 530 TREPAC" comprises a transistorized switching circuit with silicon diodes and a built-in rectifier powered from 115-vac 50/60-cps line. Having no moving parts, it is practically maintenance-free. Designed to be installed in printer housing, it eliminates line relay, rectifier, current-limiting resistors, spark suppressing filter, and printer-table wiring.—*Alcor Electronics Corp., 180 Lafayette St., New York 13, N. Y.*

For more information circle **339** on inquiry card.

LUBRICATION PROTECTOR

New "Cyclesafe" provides full protection against automatic lubrication failure: automatically stops machinery when lubrication pressure drops below a predetermined setting; is unique in that machinery completes working cycle before stopping, thereby preventing tool or die damage or breakage. Machine cannot then be restarted until failure has been corrected and pressure restored.—*Seneca Falls Machine Co., Seneca Falls, N. Y.*



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For more information circle **131** on inquiry card.

INSTRUMENTS and AUTOMATION Briefs

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Vortex Velocity Flowmeters

Consider a meter filled with fluid in a static condition as is shown in Fig. 1. When the inlet pressure exceeds the outlet pressure, fluid will flow through the meter casing. The fluid will shear at the dotted line in Fig. 1 owing to viscous friction. Fluid from the semi-circular casing will be drawn along with the flowing product and owing to the action of the Vortex-Cage, a true vortex will immediately obtain with the vortex-pool forming a constriction of the flow as shown at "A" in Fig. 2.

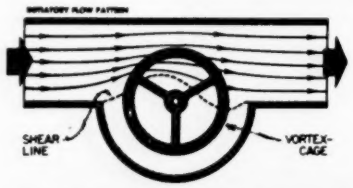


FIGURE 1

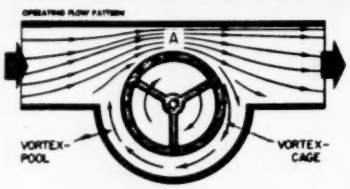


FIGURE 2

The vortex is a metastable phenomenon which is assured of establishment at the inception of flow by the operation of the Vortex-Cage. After the creation of the initial flow pattern, the Vortex-Cage functions solely as a means for counting revolutions of the Vortex-Pool. This is accomplished by allowing the Vortex-Cage pinion to actuate a mechanical register. The flow lines in Fig. 2 depict the manner in which the product and the Vortex-Pool engage each other and illustrates clearly the reason for the extraordinarily long useful life of this beautiful mechanism . . . (*From new* 4-*page Catalog RC*-1, *Rotron Controls Corp., Woodstock, N. Y.*)

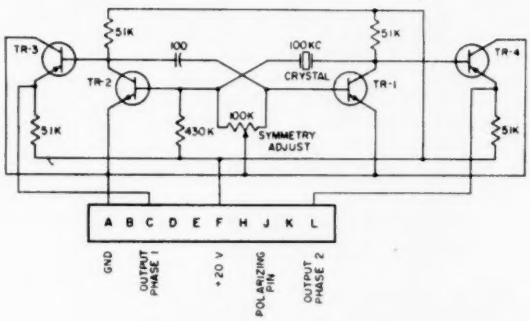
For this literature circle **401** on inquiry card.

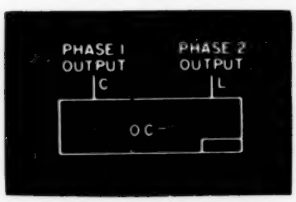
Transistorized Digital Plug-in Units

Computer Control Company is pleased to present the new series M 3C-PAC transistorized asynchronous digital plug-in printed-circuit packages.

Types of circuitry available—D.C. cross-coupled (Eccles-Jordan) flip-flop, multi-leg germanium diode gates and buffers, emitter follower, pulse amplifier, one-shot multivibrator, variable-frequency blocking oscillator, inverter amplifier, square wave oscillator, etc.

Circuit Components—Transistors, crystal diodes, pulse transformers, and linear passive elements—no vacuum tubes.



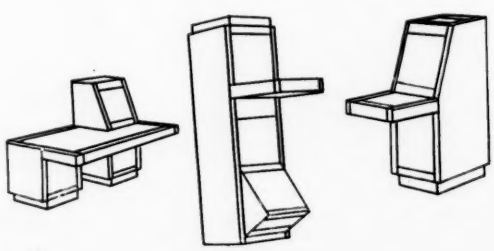


The 3C-PAC Model OC-102 (see figure) is a collector-coupled multivibrator locked to 100 KC by a quartz crystal. Bipolar outputs 180° out of phase are provided for user convenience. The multivibrator circuit utilizes two NPN switching type transistors. Isolation from the external loads and means for driving up to 10 gate loads is accomplished by emitter follower output circuits utilizing PNP-type high current gain transistors. (*From new* 20-*page Catalog M, Computer Control Co., Inc.*, 92 *Broad St., Wellesley* 57, *Mass.*)

For this literature circle **402** on inquiry card.

Modular Enclosure System

Assemblies shown are the more common applications of modular enclosures. By combining frames and various components an endless variety of assemblies may be created. (*From new* 20-*page Catalog* 101, *Amco Engineering Co.*, 7333 *W. Ainslie St. Chicago* 31, *Ill.*)



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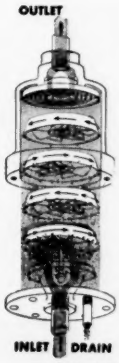

Exploded view showing ARIDIFIER operation. Capacities, 7 to 17,000 C.F.M.

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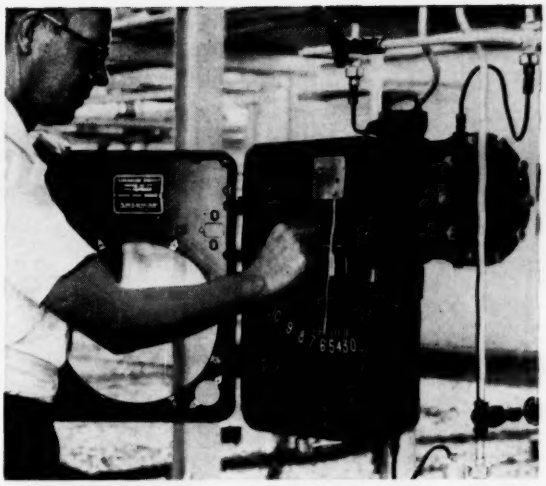

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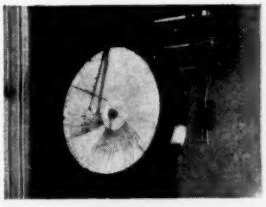

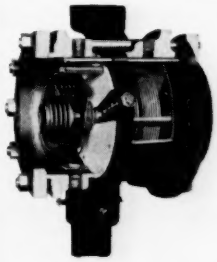

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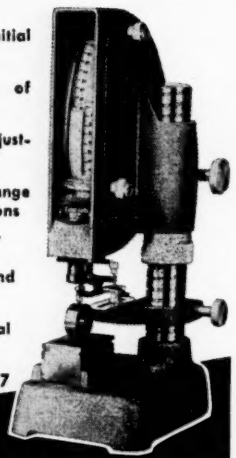

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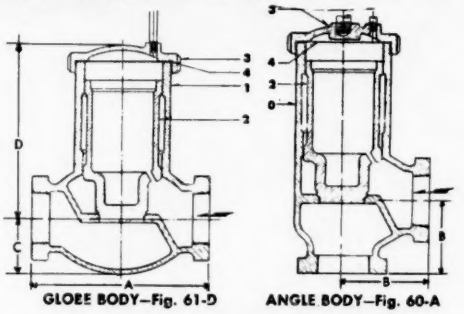
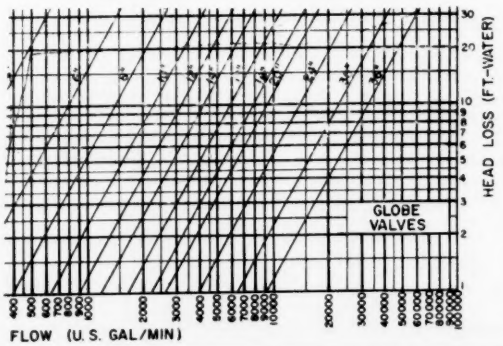
Briefs—CONTINUED

Float Valve

You will note that the pressure drop across the angle body valve is approximately 50% of the pressure drop





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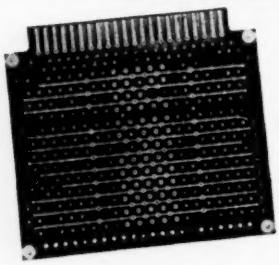

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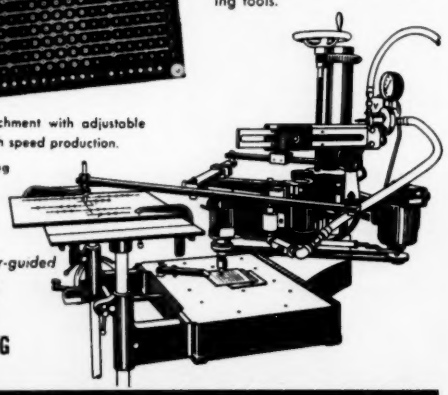

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For more information circle **136** on inquiry card.

across the globe body pattern. This would indicate strongly the advisability of using the angle body pattern wherever possible . . . (*From new 16-page Bulletin W-5, Golden Anderson Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa.*)

For this literature circle **404** on inquiry card.

Alumina Ceramics

Alumina ceramics are fired ceramic compositions in which the major crystal phase is alpha alumina, or corundum. The alumina crystals, in a finely ground state having an average particle size of five micron diameter or smaller and accompanied by fluxing agents in the form of compounds of silicon, magnesium, calcium and the like, are sintered together at temperatures of 2600°F or above to form, in most cases, a dense non-porous ceramic material.

material	Knoop Hardness Factor*	Moh's Scale
diamond	6000-6500	10
boron carbide	2230	
silicon carbide	2000	
sapphire (pure corundum)	1800	9
alumina ceramics	1450-1750	
tungsten carbide	1050-1500	
topaz	1250	8
H.S. Steel	800	
quartz	710-790	7

*Bureau of Standards tests

The outstanding characteristics of this group of products are: Permanent dimensional stability; extreme hardness; superior resistance to wear and abrasion; superior chemical inertness; refractoriness; excellent electrical properties, . . . (*From new 12-page Bulletin 1055, Coors Porcelain Co., Golden, Colo.*)

For this literature circle **405** on inquiry card.

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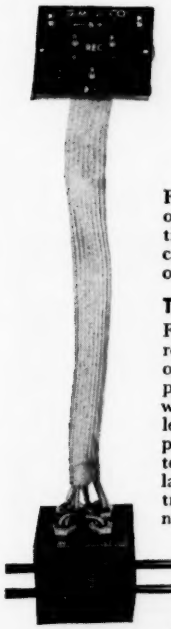

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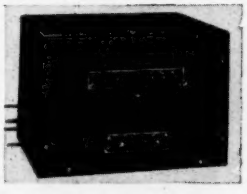

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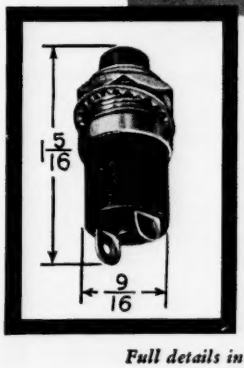
. . . ½ amp. size and price



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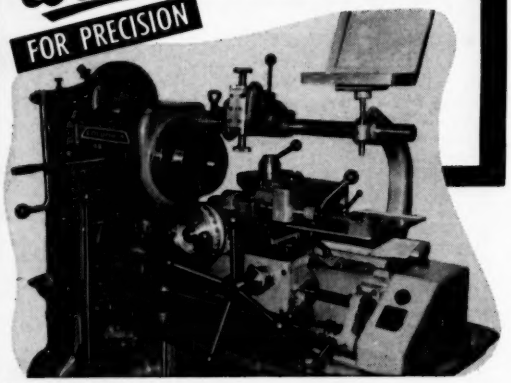

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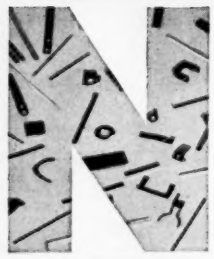

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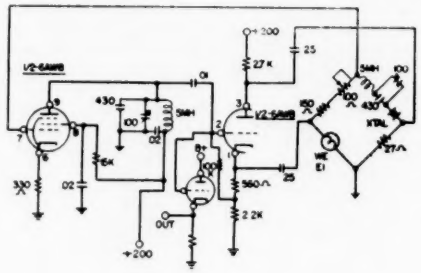
BRIEFS —CONTINUED

Quartz Crystals

A crystal unit, as well as any resonant device, can be made to oscillate with good frequency stability only if appropriate means are selected for maintaining them in oscillation.



The oscillator circuit which has been most widely used for frequency stabilization is the bridge stabilizer circuit originated by L. A. MEACHAM.

In this circuit the feedback voltage which drives the amplifier is the unbalanced voltage at the output terminals of a bridge network which includes the crystal with associated adjusting reactances, a resistor with a positive temperature coefficient of resistance, two linear-resistive arms and the necessary coupling circuits. The values of the resistors are so chosen with respect to the crystal series resistance and the Tungsten lamp resistance, that the

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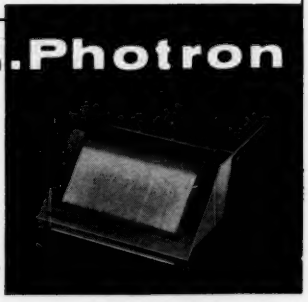

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For more information circle **142** on inquiry card.

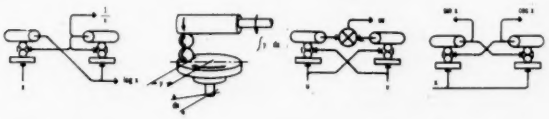
bridge is unbalanced at low levels of applied signal in such a direction that positive feedback results from the bridge unbalance output signal. As the amplitude of the oscillation builds up, more current flows through the bridge arms, causing the Tungsten lamp to increase its resistance and the bridge to approach its balance condition.

The ultimate amplitude of oscillation is reached when the bridge unbalance signal becomes small enough so that the transmission loss through the bridge equals the gain through the amplifier. (*From* 12-*page bulletin "Quartz Crystals" and Specification sheets, Quartz Crystal Div., Bulova Watch Co., Valley Stream, N. Y.*)

For this literature circle **406** on inquiry card.

Ball/Disc Integrator

The Librascope Ball/Disc Integrator is a high performance, precision, integrating mechanism useful in a wide variety of mathematical functions such as rate determination and differential analysis . . . . It finds application in an almost limitless variety of mechanical and mathematical operations. In a purely mechanical sense it may



be used as a linear position to rotary velocity converter, or as a precise variable speed drive with 0.01% reproducibility. A wide range of mathematical applications is illustrated . . . (*From new* 6-*page Catalog* 304061, *Librascope, Glendale, Calif.*)

For this literature circle **407** on inquiry card.

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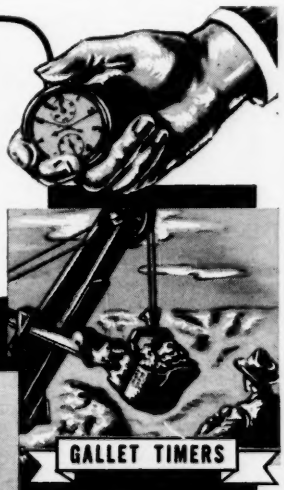
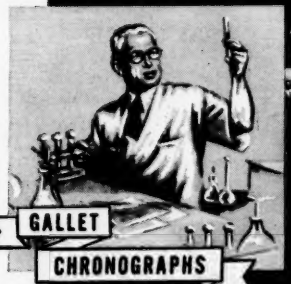


GALLET TIMERS



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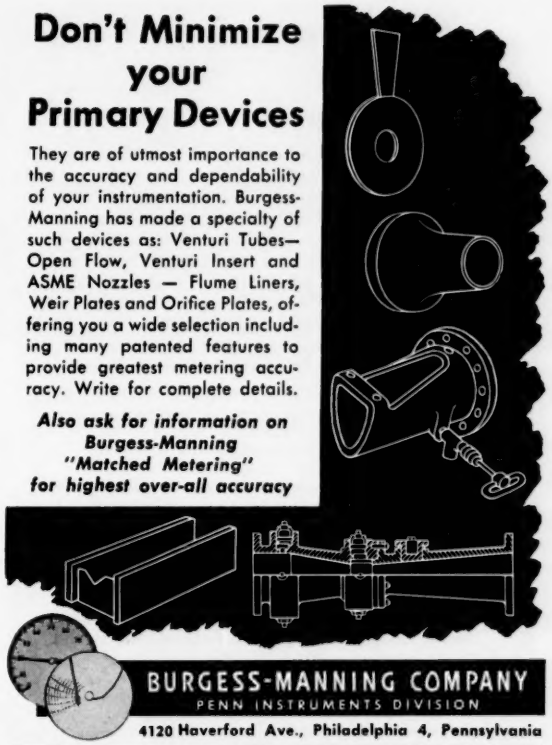

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Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

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Frequencies	400 or 1000 C.P.S. by selector switch (other frequencies on request)
Distortion	Less than 1%
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Output Power	3 watts into matched resistive load
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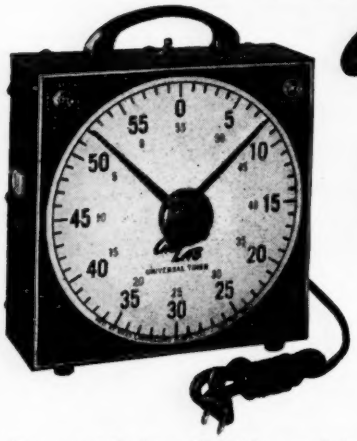

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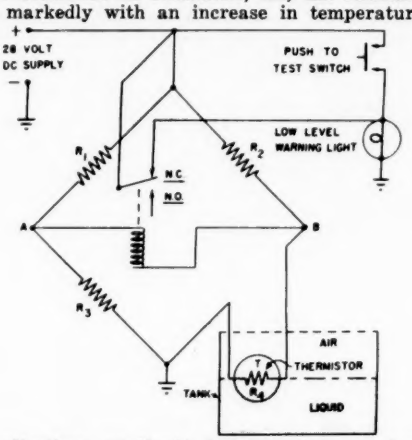
BRIEFS—CONTINUED

Thermistors In Liquid Level Systems

A thermistor is a resistor having a high negative temperature coefficient of resistance, i.e., the resistance decreases markedly with an increase in temperature . . .



Most applications of liquid level sensing require that considerable amounts of electrical power be turned on and off to operate pumps, valves, indicator lamps, etc. Thermistors are by nature "variable" resistors rather than on-off switches. In addition, it is highly desirable that the thermal response time be low so that as the liquid level covers or uncovers the thermistor, it will rapidly sense the change.

The values of R1, R2, R3, and R4 (thermistor) are

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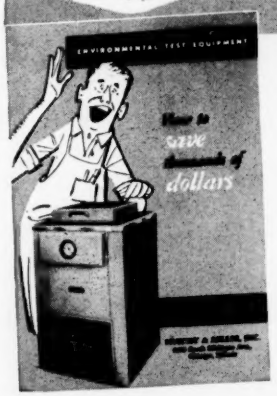

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Chicago 5, Illinois

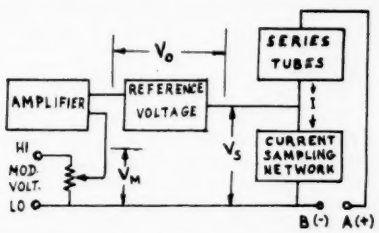
For more information circle **148** on inquiry card.

selected such that when the thermistor is uncovered by the liquid and has low resistance, the potential at B is essentially equal to that at A. Therefore, the relay is de-energized and 28 volts DC is supplied to the low level warning light through the normally closed contact . . . (*From new 10-page Bulletin AD 404, Simmonds Aerocessories, Inc., Tarrytown, N. Y.*)

For this literature circle **408** on inquiry card.

Current Governor

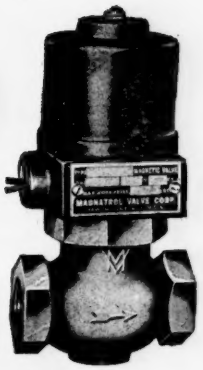
The Current Governor (Model CG-1) is basically a two-terminal device, designed for simple series connection in circuits which require current stabilization with respect to voltage and impedance variation . . . as the instrument is a high-gain feedback device, highly reactive loads may



produce spurious oscillations under certain conditions and some experimentation may be required to devise useable stable circuit configurations . . . (*From new 4-page Bulletin E-1, North Hills Electric Co., Inc., 402 Sagamore Ave., Mineola, N. Y.*

For this literature circle **409** on inquiry card.

Eliminate
Costly Flow Failures



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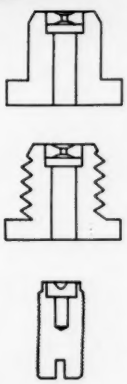

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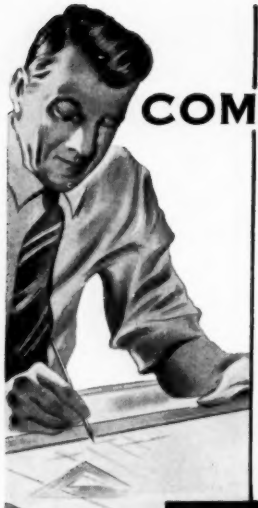

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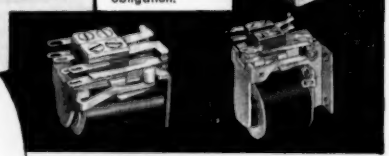

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Sensitivity 4 ohms per millivolt.

Cat. No. 4535, size 10" x 6" x 7". Range 0/1000° F,0/500°C. **$135.00**

Thermocouple-type automatic pyrometer for controlling temperature in furnaces or ovens and manufacturing processes. Leads between Simplytrol and its thermocouple sensing element may be up to 100 feet or more depending on temperature range and lead wire resistance. Load relay, 5 amperes S.P.D.T. Optional heavy duty relays to 40 A.

Either AUTOMATIC control or LIMIT shutoff. An automatic Simplytrol turns heat on and off to hold required temperature. Proportioning effect can be increased or decreased by changing cam on the sensing cycle. With shorter cycles, control more nearly approaches straight line. A limit Simplytrol locks up when the trip point is reached and remains locked until reset. Use limit Simplytrols for monitoring and safety shutoff or alarm.

Cat. No. 4532-MFP, size 5"x5½"x8" deep. Range 0/1500°F, 0/800°C. **$127.00**

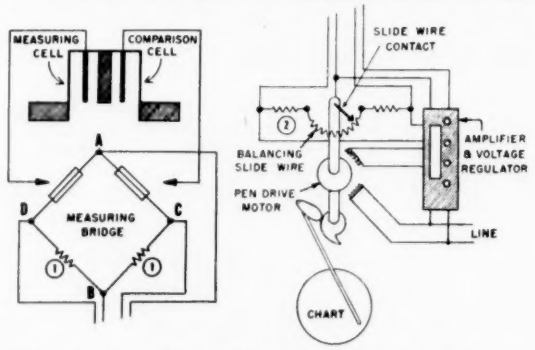
Cabinet model for wall mounting or portable shown at top. To the right is an MFP Simplytrol for flush mounting in a cabinet or control panel. Several other mountings are shown in Catalog 4-A. Send for your copy. **Assembly Products, Inc., Chesterland 10, Ohio.** Phone (Cleveland, O.) HAmilton 3-4436. (West Coast: Box XX, Palm Springs 10, Calif. Phone DHS 4-3133).

Booth 1323, Design Engineering Show, May 20-23, Coliseum, NYC

For more information circle **153** on inquiry card.

Thermal Conductivity

The Hays Condu-Therm gas analyzer uses as its principle of operation the Thermal Conductivity method of gas analysis. All gases possess an ability to conduct heat; this characteristic is known as Thermal Conductivity and



is different for each gas. When a mixture of known gas such as the products of combustion consisting of N_2,O_2, and CO_2 vary in a pre-determined relationship, the conductivity of the mixture is determined and interpreted in percent of CO_2 in the mixture.

The change in the resistance of the comparison cell resistor is compared with the change in resistance of the measuring cell resistor in the bridge circuit of the analyzer. The bridge circuit is connected into the network of the recorder where the resultant resistance measurement is amplified, indicated, and recorded. . . . (*From new 12-page Catalog 56-1008-59, The Hays Corp., Michigan City, Ind.*)

For this literature circle **410** on inquiry card.

4⅞"

2½"

For after shutdown protection...

AGASTAT®

TIME DELAY RELAY

Allows operation of auxiliary protective devices* after operating cycle is stopped. Easily installed in any electrical line.

The AGASTAT is—

- light, versatile, dependable.
- instantaneous recycling.
- unaffected by voltage variations.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in models that offer delays on energizing and de-energizing, two step delays, manually-actuated time delay switch, remote push button control.

***Write for new 4-page application folder describing how one large company solved its after-operating problem. Address Dept. A21-49**

AGA DIVISION

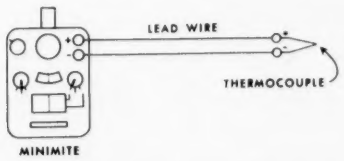
Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

For more information circle **154** on inquiry card.

Portable Pyrometer Indicator

The "MiniMite" is a null-balance potentiometer-type pyrometer indicator which provides laboratory precision . . . weighs under four pounds, and measures only 4" x 5" x 6". Despite its small size, the "MiniMite" has an unusually long scale . . . measuring over 23" . . . . uses include . . . direct temperature measurements . . . calibrate potentiometer-type instruments . . . calibrate millivoltmeter-type instruments.



Specifications

Switches—Gold plated for low contact resistance.
Dial Window—Unbreakable with hairline for accurate readings.
Voltage Reference—Standard cell.
Battery—Mercury cell. Soldered connections for trouble-free contact.
Terminals—Insulated nickel-plated binding posts. Screw caps are non-removable; cannot be lost. Will accommodate flat terminals or wire of most any gage size.
Case—Heavy-gage aluminum, corrosion resistant, grey enamel-finished.
Panel—White, easy-to-read letters on black face of enameled, corrosion-resistant, heavy-gage aluminum.
Accuracy—¼ of 1% of scale range . . . (*From new 4-page Bulletin 64, Thermo Electric Co., Inc., Saddle Brook, N. J.*)

For this literature circle **411** on inquiry card.

Who likes to keep a customer waiting? Not the men of Plummer & Kershaw at any rate. Unfortunately scheduling is easy but producing to the high quality standards that have made P & K respected, is another thing. Work done with skill and care is not work that can be produced quickly. As inevitable then as night follows day it is necessary to specify longer delivery dates—we feel sure you wouldn't want it otherwise.

TURN TO PLUMMER AND KERSHAW FOR—

- Complete Optical Instruments made to Specifications.
- Design and Manufacture of Optical Systems using Glass, Crystal or other Transmission Media.
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- Test Glasses.

PLUMMER and KERSHAW
PRECISION OPTICS
2759 Frankford Ave., Philadelphia 34, Pa.

For more information circle **155** on inquiry card.

panel or bracket mounting
an easy installation...
Waukee
FLO·METER

Whether mounted on panel or bracket, the Waukee FLO-METER is designed for quick, simple installation, with a minimum of piping. Saves time and money.

In metering more than one gas, Waukee FLO-METERS can be mounted side-by-side with standard multiple-meter manifolds available. With built-in Control Valves and large easy-to-read scales, the FLO-METER installation provides a convenient, accurate center of gas-flow control.

And the FLO-METER'S ease of cleaning — 5 minutes or less, with no tools — protects the inherent accuracy of the Waukee design.

Complete information in Bulletin 203. Write for it. **Waukee Engineering Company,** 5137 North 35th Street, Milwaukee 9, Wisconsin.

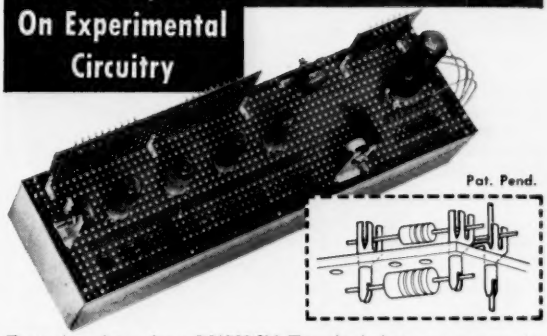
For measuring: air — ammonia — dissociated ammonia — argon — butane — city gas — endothermic cracked — exothermic cracked — forming gas — helium — hydrogen — natural gas — nitrogen — oxygen — propane.

Waukee FLO-METERS • AIR-GAS MIXORS
INDUSTRIAL WASHING MACHINES

For more information circle **156** on inquiry card.

Save Set-up Time On Experimental Circuitry

Vector **EXPERIMENTER'S CHASSIS**



Featuring the unique PUSH-IN Terminal that springs snugly into the holes of the board to provide quick set up of circuitry. The serrated edges of the terminal forks firmly grip the leads of resistors and capacitors for testing without soldering. Terminal has through hole, two side connections and small fork for transistor leads. Kit, sockets and brackets assemble with self-tapping screws.

Write for complete information.

VECTOR ELECTRONIC COMPANY
3352 SAN FERNANDO ROAD
LOS ANGELES 65, CALIFORNIA
TELEPHONE CLinton 7-8237

For more information circle **157** on inquiry card.

Trimount
MANOMETERS
for every purpose—a mounting for every installation

- **Well Type**
  Single and Multiple Tube
- **U Tube**
- **Absolute Pressure**
- **Micro Manometers**
- **Inclined Manometer**
- **Draft Gauges**
- **Indicating Flow Meters**
- **Liquid Level Gauges**
- **Electronic Level Control**

Write for New Illustrated Bulletin X

- **STURDY**
- **ACCURATE**
- **EASY READING**

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3119 WEST LAKE STREET • CHICAGO 12, ILLINOIS

For more information circle **158** on inquiry card.

Check and calibrate any type of thermocouple-actuated temperature instrument with one portable Pyrotest

Read temperatures or millivolts directly . . . without graphs, charts or conversion tables

The only portable potentiometer pyrometer with interchangeable direct reading scales

Pyrotest is 9 instruments in one, with 6 standard scales for thermocouples; 3 standard scales for millivolt readings. Special scales for any desired reading or use. Scales interchangeable in 30 seconds. Compact, rugged, easy to carry—12 lbs.; 12" x 9" x 8½". Accurate to 1/6 of 1%. Self-contained power supply. Write for new bulletin 9B.

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TECHNIQUE ASSOCIATES
211 E. SOUTH STREET
INDIANAPOLIS 25, IND.

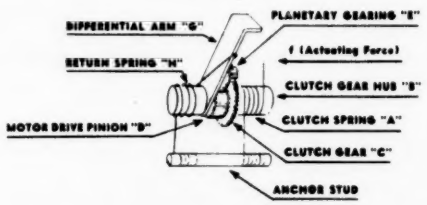
For more information circle **159** on inquiry card.

BRIEFS—CONTINUED

Time Delay Relays

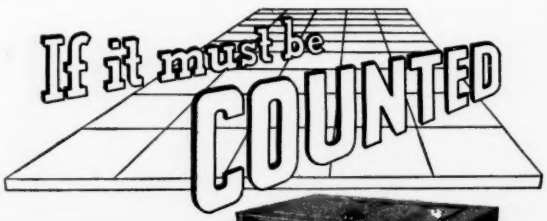
Time delay relays consist essentially of a timing motor coupled to a magnetic clutch, thus driving a lever through an angular rotation to actuate a switch after a pre-determined interval of time . . .

The comparatively small force "f" produced by the low current electromagnet pulling on the first turn of the clutch spring "A" is amplified by the friction between the spring "A" and the clutch gear hub "B" due to the rotational tendency imparted to it by the timing motor.



This amplified force tightens the second turn of the clutch spring and this force is again increased by torque from the motor, the action building up with each turn until the clutch spring "A" locks firmly around the clutch gear hub "B", holding the hub "B" stationary and causing the planetary gear "E" and arm "G" to rotate and operate the switch at the end of the desired time interval . . . (*From new 2-page Bulletin TD* 403, *A. W. Haydon Co., Waterbury, Conn.*)

For this literature circle **412** on inquiry card.



The Ametron Recording Counter

Counts faster, yet accurately.
Records in printed form.
Automatically resets.

Three important reasons why the Ametron Recording Counter is in demand by leading industrial plants and scientific laboratories.

Write for illustrated bulletin E

STREETER-AMET COMPANY
GRAYSLAKE, ILLINOIS
THE STANDARD OF ACCURACY SINCE 1888

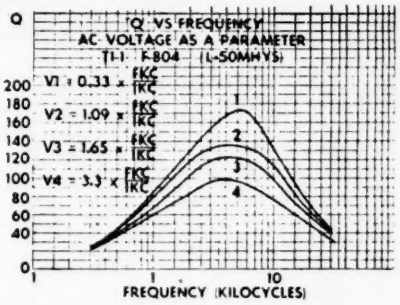
For more information circle **160** on inquiry card.

Toroidal Inductors

The apparent inductance at any frequency f is given by the expression

$$L_{app} = L/1 - \left(\frac{f}{f_o}\right)^2$$

where L is the nominal inductance.
For frequencies well below the resonant f_o the fractional



increase in inductance due to the distributed capacity C_o is approximately

$$\triangle L/L = (f/f_o)^2 = w^2LC_o$$

The graphs showing the coil characteristics make use of the following formulas:

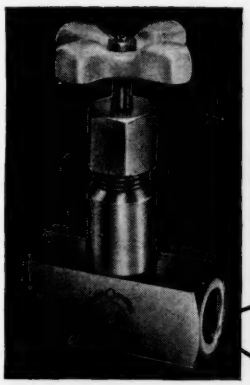
1. "Q" vs. frequency was measured with voltages given by the expression

$$V = K\sqrt{LH} \times FKC/1KC$$

where K is a constant listed on every chart, LH is inductance in Henries, FKC is the frequency in kilocycles at which the measurements were made . . . . (*From new 48-page Catalog* 571, *Freed Transformer Co., Inc.*, 1718-1736 *Weirfield St., Brooklyn* (*Ridgewood*) 27, *N. Y.*)

For this literature circle **413** on inquiry card.

For more information circle **161** on inquiry card.

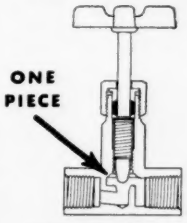


MARSH
Needle Valves

MAXIMUM WORKING PRESSURE 10,000 PSI

. . . for finer regulation of water, oil or gas

First needle valve to combine all the characteristics called for in modern industry. Embodies sturdiest basic construction—machined from solid bar stock—suitable for pressures to 10,000 psi and equally efficient in lower range. Note stem guide fused to body by new "Conoweld" process, eliminating faults of conventional two-piece valves. Stem 416 stainless steel. Stem threads fine pitch for strength and micrometer regulation. Body electro-zinc plated. Sizes ⅛" to 1", globe and angle patterns.



Ask for new Needle Valve Catalog

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* Dpt. 42, Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd Street, Edmonton, Alberta, Canada

For more information circle **162** on inquiry card.

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NEW
PANTO-GRAVER
3D
Solves all Your Industrial Engraving and Die-Sinking Problems
MODEL SR-3D
3 DIMENSIONAL
Engraves
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DIALS & TOOLS
Copies
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EMBOSSING PUNCHES
Do Your Own General Engraving and Die-Sinking right in Your Own Plant at Lower Costs.
The AL-3 Sharpener
Ratio Reduction Range
from 2:1 to 6:1 giving 23 dimensions from one guide
AUTOMATIC SHARPENING
of Engraving Cutters. No Special Skill is required to keep a fine milling edge on your cutting tool
WRITE FOR ILLUSTRATED FOLDER—Code GIRYX
GEO. SCHERR CO., Inc.
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200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

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NEW

ALI VTVM TYPE 810

Featuring:

- Balanced amplifier for high stability
- 700 mc high frequency probe — smallest in the industry
- Voltage regulator provides stable dc for ohmmeter, minimizing line voltage effects
- High loop gain in the amplifier and total feedback assure long-time accuracy and nullify tube parameter variations
- Balancing diode used to match characteristics of probe, adding further stability

This VTVM, a new presentation from Acton Laboratories, provides circuit improvements and techniques which combine to give stable characteristics and long-time accuracy. The mechanical design provides an instrument of convenient size, and a miniature thermionic diode probe. Color coded meter scales, properly grouped, provides exceptional readability on all ranges.

SPECIFICATIONS

Voltage Ranges:
DC — Full scale ranges 1-3-10-30-100-300-1000 Volts (Plus and Minus)
AC — Full scale ranges 1-3-10-30-100-300 Volts (RMS)
Resistance Ranges:
0.2 — 500 ohms scale; multipliers, X1, X10, X100, X1K, X10K, X100K, X1M
Accuracy:
DC: ±2% AC: ±3%
Frequency Response:
±1 db; 10 cps to 700 mc

Write ALI for complete technical information — published in Laboratory Report, Vol. II, No. 1.

Acton Laboratories, Inc.
533 MAIN STREET, ACTON, MASS.

For more information circle **164** on inquiry card.

INSTRUMENTS and AUTOMATION

New Literature

AUTOMATION

COMPUTING RELAY. New 4-page Brochure P99-3 describes features, application, and operating characteristics of computing relay for pneumatic control systems.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.
Circle **414** on inquiry card.

PRODUCTS AND SERVICES. New 28-page Bulletin GSP-901 provides information on the company's various products and services.—Hagan Chemicals and Controls, Inc., Pittsburgh 30, Pa.
Circle **415** on inquiry card.

CONTROL SYSTEMS. New 4-page Bulletin CS describes complete control systems for use on processing equipment, plastic machines, furnace installations, or other temperature control operations.—West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.
Circle **416** on inquiry card.

DRILL PRESS CONTROL. New 6-page Bulletin GL-5704 contains method of operation of numerically controlled position table.—Jones & Lamson Machine Co., Springfield, Vt.
Circle **417** on inquiry card.

SYSTEM ENGINEERING. New 4-page brochure describing facilities, personnel, and philosophy of Systron Corporation, 2055 Concord Blvd., Concord, Calif.
Circle **418** on inquiry card.

MOTORS, SERVOS

MOTORS. New 4-page Bulletin 3461 describes maker's "Type DIE" nonventilated flat-type motor and "Type DIF" fan-cooled model.—Diehl Mfg. Co., Finderne Plant, Somerville, N. J.
Circle **419** on inquiry card.

D-C MOTORS. New 2-page specification sheet provides engineering data on special-purpose d-c motors.—Induction Motors Corp., 570 Main St., Westbury, L. I., N. Y.
Circle **420** on inquiry card.

D-C MOTORS. New 4-page Bulletin F-4344-4 describes maker's permanent-magnet d-c motors and tachometer generators, Type BYLM.—2-page F-6573-3 furnishes information on smaller counterpart, Type EYLM.—Barber-Colman Co., Rockford, Ill.
Circle **421** on inquiry card.

SERVO MOTORS. New 10-page Bulletin 385 provides characteristics, drawings, and application data of Servo Motors.—Norden-Ketay Corp., Commerce Rd., Stamford, Conn.
Circle **422** on inquiry card.

VALVES, ACTUATORS

RELIEF VALVE. New 4-page Bulletin P-282 provides data on maker's "Dia-Grid" gas relief valves.—Fisher Governor Co., Marshalltown, Iowa.
Circle **423** on inquiry card.

VALVES. New 8-page Catalog 200 provides data and charts on Hancock bronze and steel hand valves.—Manning, Maxwell & Moore, Inc., Watertown, Mass.
Circle **424** on inquiry card.

CUSHIONED FLOAT VALVES. New 16-page Bulletin W-5 describes maker's cushioned float valves.—Golden Anderson, Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa.
Circle **425** on inquiry card.

HYDRAULIC PILOT VALVE. New 2-page Catalog Sheet HCP-56 describes and illustrates maker's hydraulic control pilot No. 811 for diaphragm valves.—Atlas Valve Co., 280 South St., Newark 5, N. J.
Circle **426** on inquiry card.

REDUCING VALVE. New 4-page Bulletin 981 contains information on maker's Type 44 piston-operated, single-seated pressure reducing valve for steam service.—A. W. Cash Co., P. O. Box 551, Decatur, Ill.
Circle **427** on inquiry card.

CHECK VALVES. New 2-page bulletin presents maker's new MS-type Series 1800 lightweight aluminum check valves.—Tactair Valve Div. of Aircraft Products Co., 300 Church Rd., Bridgeport, Pa.
Circle **428** on inquiry card.

VALVE ACTUATORS. New 8-page Catalog T-82 provides information on maker's electrically controlled valve operating units.—Tork-Master Div. of Harvill Corp., 6251 W. Century Blvd., Los Angeles 45, Calif.
Circle **429** on inquiry card.

MICRO VALVE. New 4-page Data Sheets describe maker's Model 167 toggle operated micro valve for 3-way control.—Barworth, Inc., 7 Industrial Place, Summit, N. J.
Circle **430** on inquiry card.

TEMPERATURE

TEMPERATURE PROBES. New 2-page Bulletin 25720 contains general specifications for maker's Models 108, 110 and 119 temperature probes.—Rosemount Engineering Co., Rosemount, Minnesota.

Circle **431** on inquiry card.

HEATING CONTROLS. New 16-page Booklet F-7773 describes maker's automatic electric control systems for heating and ventilating.—Barber-Colman Co., 1300 Rock St., Rockford, Ill.

Circle **432** on inquiry card.

TEMPERATURE RECORDER. New 2-page Data Sheet E-ND46 (7) describes the Speedomax G high precision resistance thermometer recorder.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

Circle **433** on inquiry card.

TEMPERATURE INDICATORS. New 4-page Data Sheet ND46-33(23) contains information on maker's electronic Speedomax G potentiometer instruments for indicating thermocouple temperatures on a drum-type scale 25½" long.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

Circle **434** on inquiry card.

TEMPERATURE CONTROLLER. New 4-page Bulletin 56 provides information on maker's new temperature controller for laboratory and pilot plant uses.—Bayley Instrument Co., Box 538, Danville, Calif.

Circle **435** on inquiry card.

TEMPERATURE PROBLEMS. New 8-page Bulletin TR-544 describes use of steel and alloys, and mechanical and physical reactions of the materials under various high-temperature and corrosive environments.—The Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

Circle **436** on inquiry card.

HEATERS AND DEVICES. New 72-page Catalog GEC-1005H contains information on maker's heaters and heating devices. Contains also a 16-page power requirements section.—General Electric Co., Schenectady 5, N. Y.

Circle **437** on inquiry card.

TEMPERATURE CONTROLLERS. New 4-page Bulletin P-257 provides information on maker's controllers to control automatically building temperatures from outdoors.—Automatic Devices Co., Inc., 714 Hillgrove Ave., Western Springs, Ill.

Circle **438** on inquiry card.

FLOW

VENTURI TUBES. New 2-page Bulletin 400 describes maker's venturi tubes, designed for installation in standard pipe lines.—Burgess-Manning Co., Penn Instruments Div., 4110 Haverford Ave., Phila. 4, Pa.

Circle **439** on inquiry card.

SIE

MODEL C-6

RESISTANCE METER

DIRECT READING FROM 0 OHMS TO 10,000,000 MEGOHMS

- 3 TEST VOLTAGES: 1½, 50, 500 VOLTS
- ACCURATE WITHIN 3% TO 1,000,000 MEGOHMS
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No matter what your wire or insulation requirements may be, you can depend on Gordon "Serv-Rite" insulated wire for pyrometers—recognized as a standard of highest quality for nearly half a century. All "Serv-Rite" wire is now manufactured in the new, completely modern Gordon plant, employing up-to-date equipment and machinery, supervised and operated by skilled technicians—your guarantee of continued precision quality. In addition to maintaining large stocks of all common types of wire, Gordon will manufacture special insulation, in long or short runs, to suit your individual needs and meet your most rigid specifications.

All Types of Insulation

Felted Asbestos
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Stainless Steel Armored Braid
Silicone Treated
Cotton Braid
Lead Jacket

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5484

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2025 Hamilton Avenue, Cleveland 14, Ohio

For more information circle **166** on inquiry card.

ANEMOMETERS. New 2-page Bulletin provides information on maker's hot-wire anemometers.—Flow Corp., 238 Concord Ave., Cambridge 38, Mass.

Circle **440** on inquiry card.

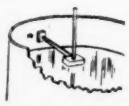
LIQUID FILTERS. New 16-page Bulletin LFC-556 provides information on maker's new metal liquid filters, with complete data for designers.—The Air-Maze Corp., 25000 Miles Rd., Cleveland 28, Ohio.

Circle **441** on inquiry card.

AIR PUMPS. New 16-page Catalog 1957 describes maker's rotary air and vacuum pumps.—Leiman Bros., Inc., 146-181 Christie St., Newark 5, N. J.

Circle **442** on inquiry card.

LEVEL



LEVEL RECORDER. New 4-page Bulletin M31-2 presents maker's recorder that compensates weight of water resulting from temperature variations, measures water level in inches, using drum pressure as index.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

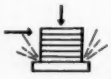
Circle **443** on inquiry card.

LEVEL SWITCHES. New 2-page Bulletin 1066 describes float switches, designed to indicate or control liquid-oxygen level.—Revere Corp., of America, Wallingford, Conn.

Circle **444** on inquiry card.

LIQUID LEVEL GAUGE. New 4-page Bulletin 501 contains information on maker's 3 models full-length tank gauge.—New 4-page Bulletin 116 describes maker's dial-type remote reading tank gauge.—Liquidivision Gauge & Control Corp., P. O. Box 51, Oceanside, Long Island, N. Y.

Circle **445** on inquiry card.



PRESSURE, WEIGHT

PRESSURE TRANSMITTERS. New 4-page Bulletin No. 56-13A describes and illustrates maker's Type VDP differential pressure transmitter its range adjustments and settings.—New 4-page Bulletin No. 56-12 discusses the Type VP pressure transmitter.—Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.

Circle **446** on inquiry card.

PRESSURE TRANSDUCER. New 2-page specification sheet contains information on new Swiss-made pressure-rate indicator, Model PI-114, for measuring rate of change of pressure.—Kistler Instrument Co., 15 Webster St., North Tonawanda, N. Y.

Circle **447** on inquiry card.

PRESSURE REGULATOR. New 2-page bulletin provides specifications on the "Futurecraft Hi/Lo Hand Loader" for high pressure gases.—Futurecraft Corp., 1717 North Chico Ave., El Monte, Calif.

Circle **448** on inquiry card.

PRESSURE SENSING. New 4-page Bulletin 276 contains information on maker's pressure sensitive devices.—Clark Electronic Laboratories, Box 165, Palm Springs, Calif.

Circle **449** on inquiry card.

GRAVIMETRIC FEEDER. New 4-page Bulletin No. 35-N62 contains data on maker's Model 37-20 "Hi-Weigh" belt gravimetric feeder.—Omega Machine Co., Providence 1, R. I.

Circle **450** on inquiry card.

MICROBALANCE. New 4-page bulletin illustrates and describes maker's electrobalance with a new approach to the measurement of mass units.—Cahn Instrument Co., 7712 Danvers Street, Downey, Calif.

Circle **451** on inquiry card.

FORCE, ACCELERATION, VIBRATION

FORCE INDICATOR. New 2-page bulletin P-5700 describes maker's indicator—Model 182 (DC meter type) for indication of telemetered information from strain gage type transducers.—Taber Instrument Corp., 111 Goundry St., North Tonawanda, N. Y.

Circle **452** on inquiry card.

ACCELEROMETERS. New 26-page brochure presents specifications and dimensions of maker's "Models GLH, DDL, GMO, GMT and GDM accelerometers.—Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.

Circle **453** on inquiry card.

VIBRATION ANALYZERS. New two-page Bulletin provides information on new portable type vibration analyzers, models 300 and 400.—International Research & Development Corp., Columbus, Ohio.

Circle **454** on inquiry card.

TIME, SPEED, COUNT

DIGITAL DIAL. New 2-page Data sheet 54-91 describes maker's direct-reading, turns-counting digital dial.—Helipot Corp., Newport Beach, Calif.

Circle **455** on inquiry card.

ELECTRIC COUNTERS. New 4-page Bulletin contains illustrations, technical data on Swiss-made electric reset impulse counters.—Landis & Gyr, Inc. 45 West 45 St., New York 36, N. Y.

Circle **456** on inquiry card.

SYNCHRONOUS MOTORS. New 2-page Form 150 contains specifications and descriptions of special features and uses of maker's synchronous timing motors.—The Lux Clock Mfg. Co., Inc., 95 Johnson St., Waterbury 20, Conn.

Circle **457** on inquiry card.

VARIABLE SPEED DRIVE. New 7-page Bulletin K-200 contains information on the operating characteristics of the "Cleveland Speed Variator."—Cleveland Worm and Gear Co., 3261 E. 80th St., Cleveland 4, Ohio.

Circle **458** on inquiry card.

HUMIDITY, WATER

HUMIDITY CHAMBER. New 2-page bulletin describes and illustrates maker's Blue M vapor-temp humidity chamber.—Blue M Electric Co., 138th and Chatham St., Blue Island, Ill.

Circle **459** on inquiry card.

WATER FILTERS. New 2-page Data Sheet 6321 discusses maker's type "C" vertical pressure filters suited for water in small industrial plants.—Cochrane Corp., 17th St. below Allegheny Ave., Phila. 32, Pa.

Circle **460** on inquiry card.

STEAM, AIR, GAS

COOLING TOWER CONTROL. New 4-page Bulletin 1050 discusses new system for automatically controlling make-up water flow, chemical feed, and blowdown rate of cooling towers.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **461** on inquiry card.

STEAM TRAPS. New 8-page Catalog No. 600 presents maker's float-thermostatic steam valve to drain steam-hot condensate.—Velan Valve Corp., 37 South River St., Plattsburg, N. Y.

Circle **462** on inquiry card.

MANUAL LOADING STATIONS. New 8-page Bulletin 1031 describes makers line of auto-manual pneumatic loading stations for use as components in combustion control, feed-water regulation and control duties in steam power plants.—Copes-Vulcan Div., Blaw-Knox Co., Erie 4, Pa.

Circle **463** on inquiry card.

AIR FILTERS. New 2-page Catalog Sheet provides data on maker's felt media type, and metal media type instrument air filters.—Air-Maze Corp., 2500 Miles Rd., Cleveland 28, Ohio.

Circle **464** on inquiry card.

LIQUID-GAS SEPARATOR. New 10-page Bulletin S1052 describes the "Liquid-Jector," a liquid-gas separation device for the removal of entrained liquids and solids from air, gas and steam systems.—Sales Corp. of America, Dresher, Pa.

Circle **465** on inquiry card.

COMMUNICATIONS

PORTABLE COMMUNICATOR. New 4-page Brochure C-101 describes and illustrates "Avcom Mark 1," a miniaturized transistorized "Walkie-Talkie."—Avco Mfg. Corp., Crosley Div., 1329 Arlington St., Cincinnati 25, Ohio.

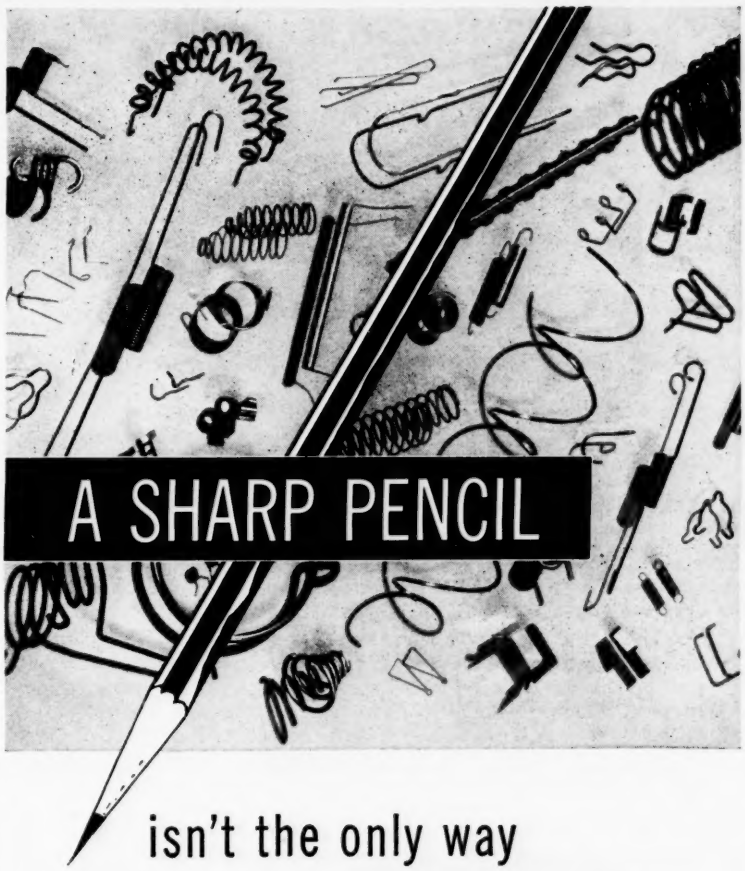
Circle **466** on inquiry card.

LOUDSPEAKERS. New 2-page Bulletin 78A17 graphically illustrates the wide variety of uses for maker's new ultra-lightweight portable soundcasting systems.—University Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, N. Y.

Circle **467** on inquiry card.

NUCLEONICS

GEIGER COUNTER. New 4-page issue of "RCL Counter" Vol. 4, No. 1



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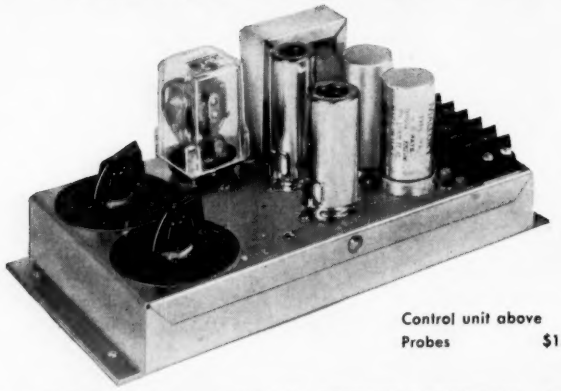

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illustrates construction and compares operating characteristics of maker's all-glass halogen quenched counters with those of other halogen and organic counters.—Radiation Counter Labs., Inc., Nucleonic Park, Skokie, Ill.

Circle **468** on inquiry card.

MONITOR SYSTEM. New 2-page Bulletin contains information on the UAC five-channel radiation monitor system for Neutron, Alpha, Beta, and Gamma radiation monitoring.—Universal Atomics Corp., 50 Bond St., Westbury, L. I., N. Y.

Circle **469** on inquiry card.

RADIATION PROTECTION. New 4-page Bulletin 407 contains information on services for health and safety precautions against hazards of radioactivity.—Nuclear Science and Engineering Corp., P. O. Box 10901, Pittsburgh 36, Pa.

Circle **470** on inquiry card.

LABORATORY

LAB. GLASSWARE. New 16-page Catalog 80C100 describes maker's line of glassware fabricated from Pyrex brand glass.—Fischer & Porter Co., Hatboro, Pa.

Circle **471** on inquiry card.

LABORATORY EQUIPMENT. New 16-page March issue of "Lab-oratory" gives a complete description and illustrations of the new laboratory aids such as ovens, pH meter, incubator etc.—Schaar & Co., 754 W. Lexington St., Chicago 7, Ill.

Circle **472** on inquiry card.

LABORATORY APPARATUS. New 20-page Bulletin No. 7 provides data on Beckman pocket pH meters, lab ovens, analytical and dispensing balances, a variety of stirrers, etc.—Arthur S. LaPine & Co., 6001 South Knox Ave., Chicago 29, Ill.

Circle **473** on inquiry card.

LAB CART. New 8-page leaflet describes maker's "Labconco" chemical, glassware, pan-type, flask carrier carts, etc.—Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.

Circle **474** on inquiry card.

CENTRIFUGES. New 4-page Bulletin BFE-57 describes, maker's "Superspeed SS-1" angle centrifuge that has a top speed of 16,000 rpm (32,700 x G), and a maximum capacity of 400 ml.—Ivan Sorvall, Inc., Norwalk, Conn.

Circle **475** on inquiry card.

LABORATORY APPARATUS. New 17-page Bulletin D5527 provides information on apparatus and chemicals marketed by company.—Harshaw Scientific, Div. of the Harshaw Chemical Co., Cleveland 6, Ohio.

Circle **476** on inquiry card.

RESINS. New 4-page Price List "M" gives information on analytical-grade

anion exchange resins, cation exchange resins, and monobed resins. Contains also tabulation of properties, and bibliography on subject of ion exchange.—Bio-Rad Laboratories, 800 Delaware St., Berkeley, Calif.

Circle **477** on inquiry card.

LABORATORY WARE. New 14-page Bulletin 57A describes maker's polyethylene laboratory ware.—Bel-Art Products, 4917 Murphy Pl., West New York, N. J.

Circle **478** on inquiry card.

ANALYTICAL

CO ANALYZERS. New 4-page Bulletin No. 0702-1 describes and illustrates maker's safety appliances for detection of carbon monoxide accumulations.—Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle **479** on inquiry card.

MASS SPECTROMETERS. New 7-page Bulletin MS-3 contains description and specifications for maker's two models mass spectrometers featuring simplicity, high resolution, and fast response.—Bendix Aviation Corp., Research Laboratories Div., P. O. Box 5115, Detroit 35, Mich.

Circle **480** on inquiry card.

ANALYTICAL INSTRUMENTS. New 16-page Catalog describes maker's line of infrared and ultraviolet spectrophotometers, monochromotors, flame photometers, vapor fractometers, as well as accessories and instrument components; also process control instruments.—Perkin-Elmer Corp., Norwalk, Conn.

Circle **481** on inquiry card.

CHROMATOGRAPHY. New 6-page Bulletin 831 describes maker's "Kromo-Tog". Model K-3, for gas and vapor-phase chromatography.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Circle **482** on inquiry card.

SPECTROCHEMICAL ANALYSIS. New 28-page Hilger Catalog CH 401 provides general principles and bibliography on spectrochemical analysis.—Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Circle **483** on inquiry card.

ELECTROCHROMATOGRAPHY. New 6-page Brochure EC-301 describes operation of Karler-Misco electrochromatography set, with suggestions for processing proteins, non-proteins, inorganic ions, large particles, etc.—Microchemical Specialties Co., 1834 University Ave., Berkeley 3, Calif.

Circle **484** on inquiry card.

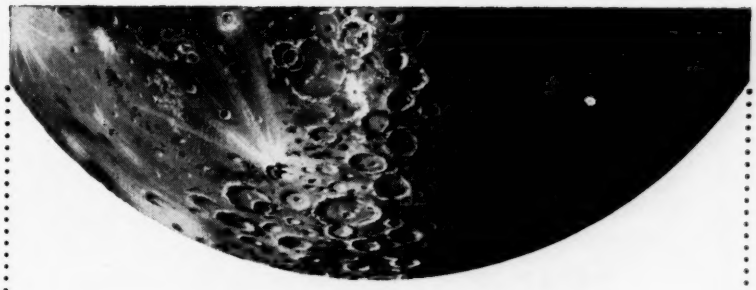
RECORDING

MULTIPOINT RECORDERS. New 2-page Bulletin F-7955 describes Series 8000 electronic multi-point recorder with up to sixteen records.—Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.

Circle **485** on inquiry card.

XEROGRAPHY. New 6-page Bulletin 1056 illustrates fully automatic reproductions from original documents or roll microfilm.—The Haloid Co., Rochester 3, N. Y.

Circle **486** on inquiry card.



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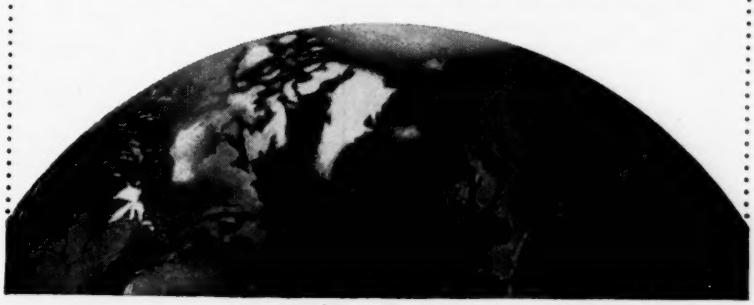

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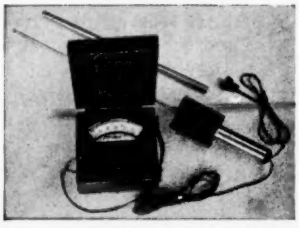
RAWSON-LUSH Rotating Coil GAUSSMETER



Tiny coil (approx. 3 mm diameter) rotates in the field to be measured. The voltage generated is rectified in a synchronous rectifier and used to deflect a Rawson high sensitivity voltmeter with scale calibrated in kilogausses.

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CAMERA LENSES. New 6-page brochure illustrates and describes Angenieux wide-angle Retrofocus lenses for 35-mm cameras.—Exakta Camera Co., 705 Bronx River Rd., Bronxville 8, N. Y.

Circle **487** on inquiry card.

MICROFILM INFORMATION. New 36-page Brochure "New Horizons with Microfilm" describes techniques for "unitizing" microfilm etc.—Filmsort Div., Dexter Folder Co., Pearl River, N. Y.

Circle **488** on inquiry card.

DATA TRANSCEIVER TESTS. New 24-page booklet contains a report of tests conducted on IBM Data Transceivers and Associated Telephone Circuits.—The Chesapeake and Ohio Railway Co., Terminal Tower, Cleveland 1, Ohio.

Circle **489** on inquiry card.

OSCILLOGRAM READER. New 2-page Bulletin CR-187 describes maker's models of Oscillogram Readers.—Coleman Engrg. Co., Inc., 6040 West Jefferson Blvd., Los Angeles 16, Calif.

Circle **490** on inquiry card.

MILLIAMMETERS. New 4-page Bulletin 157 describes maker's recording d-c milliammeters.—The Esterline-Angus Co., Inc., P. O. Box 596 Indianapolis 6, Ind.

Circle **491** on inquiry card.

COMPUTING

LINEAR PROGRAMMING. New 6-page reprint provides information on linear programming on an electronic analog computer.—Reeves Instrument Corp., 215 East 91st St., New York 28, N. Y.

Circle **492** on inquiry card.

LINEAR PROGRAMMING COMPUTERS. New 2-page Technical Data Sheet 113 describes maker's new "Reac LP 402-1 and LP 402-2" linear programming computers.—Reeves Instrument Corp., 215 E. 91st St., New York 28, N. Y.

Circle **493** on inquiry card.

ANALOG COMPUTER. New 4-page bulletin presents maker's Model 3000 analog computer with building block design.—Donner Scientific Co., Concord, Calif.

Circle **494** on inquiry card.

TESTING, GAGING, INSPECTION

ELECTRONIC TESTING. New 4-page catalog S-57 describes maker's complete line of electronic test instrumentation.—Shasta Div., Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif.

Circle **495** on inquiry card.

ULTRASONIC TESTING. New 2-page bulletin G-1 presents maker's equipment for metal cleaning and ultrasonic testing.—Branson Ultrasonic Corp., 37 Brown House Rd., Stamford, Conn.

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quick disconnect
MINIATURE CONNECTORS

OUTSTANDING FEATURES:

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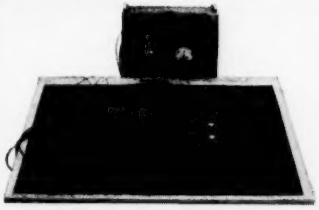

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INSPECTION GAGE. New 2-page bulletin describes and illustrates makers' "Microtrol" automatic inspection gage Model 6098 for cylindrical parts. —Airborne Instruments Lab. Inc., 160 Old Country Road, Mineola, N. Y.
Circle **497** on inquiry card.

HARDNESS TESTERS. New 4-page Bulletin RH-12-54 describes portable hardness testers for on-the-spot Rockwell readings with A, B, C, D, F, and G scales.—Riehle Testing Machines, Div. of American Machine and Metals, Inc., East Moline, Ill.
Circle **498** on inquiry card.

DIAMETER CONTROL. Two new 4-page Brochures 204 and 206 describes continuous non contact diameter measurement and control equipment for insulated wire and cable, extruded tubing and shapes. Industrial Gauges Corp., West Englewood, N. J.
Circle **499** on inquiry card.

TEST EQUIPMENT. New 4-page Bulletin contains information on maker's Wideband Amplifier-WA 600 and Oscillator Model PG-650 and other units for in ultrasonic test equipment. —Arenberg Ultrasonic Lab., Inc., 94 Green St., Jamaica Plain 30, Mass.
Circle **500** on inquiry card.

SOIL TESTING. New 60-page manual contains information on maker's apparatus for unconfined compression tests of cohesive soils.—Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.
Circle **501** on inquiry card.

INDICATOR GAGE. New 4-page bulletin presents typical applications of indicator gages to check diameters of blind holes, measuring outside and inside diameters of shallow circular slots, etc.—Ellstrom, Inc., 25939 Van Born Rd., Dearborn, Mich.
Circle **502** on inquiry card.

FATIGUE TESTER. New 2-page Bulletin 5A provides information on maker's "BA-12" instrument that provides a standard of measurement for checking steadily repeated dynamic strain gage signals.—Ellis Associates, Box 77, Pelham, N. Y.
Circle **503** on inquiry card.

ALIGNMENT INSTRUMENT. New 4-page bulletin presents information on maker's "King-Way" Machine tool alignment instrument.—King Instrument Co., 804 Northwestern Bank Bldg., Minneapolis 2, Minn.
Circle **504** on inquiry card.

TUBING, PIPING

STAINLESS TUBING. New 14-page loose-leaf technical data file ASL #285 and ASL #286, offers information on BW& Croloy 27-4-1 (Type 329) stainless tubing, and ASL #286 furnishes the same information on B&W Croloy 25-12 (type 309S).—The Babcock & Wilcox Co., Tubular Prods. Div., Beaver Falls, Pa.
Circle **505** on inquiry card.

TIN-LINED PIPE. New 4-page Bulletin No. 139 presents line of tin-lined pipe, fittings, line valves, faucets, and accessories for distribution systems of distilled water.—Barnstead Still & Demineralizer Co., 243 Lanesville Ter., Boston 31, Mass.
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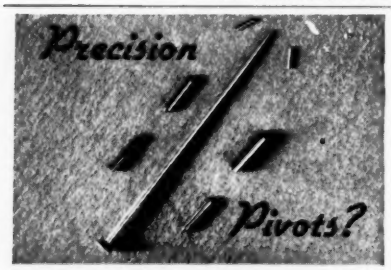

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PIPE NIPPLES. New 4-page Catalog 756 explains maker's roll-indented markings for identifying seamless steel, wrought iron and welded steel pipe nipples.—Pittsburgh steel pipe nipples. Nipple Works, Inc., 1455 Spring Garden Ave., Pittsburgh 12, Pa.

Circle **507** on inquiry card.

TEFLON TUBING AND ROD. New 2-page Bulletin T-300 describes Teflon heavy-walled tubing and rod.—Halocarbon Div., Haveg Industries, Inc., 900 Greenbank Rd., Wilmington 8, Del.

Circle **508** on inquiry card.

PLASTIC CLOSURES. New 30-page loose leaf file provides important data on threaded and non-threaded caps and plugs for safeguarding products in process, storage and transit.—Caplugs Div., Protective Closures Co., Inc., 2207 Elmwood Ave, Buffalo 23, N. Y.

Circle **509** on inquiry card.

ELECTRICAL INSTRUMENTS

A-C AMMETERS. New 2-page Data Sheet 839 discusses the high-accuracy features stressed in maker's new a-c linear-scale ammeter line.—Helipot Technical Information Service, Newport Beach, Calif.

Circle **510** on inquiry card.

MAGNETIZERS. New 2-page Bulletin 17 provides information on two types of magnetizers: the electromagnetic, and the permanent-magnet type.—The Indiana Steel Products Co., Valparaiso, Ind.

Circle **511** on inquiry card.

INSTRUMENTS AND COMPONENTS. New 8-page Condensed Catalog illustrates and describes maker's precision measuring instruments, scientific apparatus, industrial test and control equipment and components.—General Radio Co., 275 Massachusetts Ave. Cambridge 39, Mass.

Circle **512** on inquiry card.

WATTHOUR METERS. New 64-page booklet GEC-1400 covers maker's single-phase, polyphase and watthour demand meters, water heater time switches, meter sockets, etc.—General Electric Co., Schenectady 5, N. Y.

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RESISTANCE BRIDGES. New 8-page Bulletin L-19B describes maker's seven bridges for d-c resistance measurements from 1 micro-ohm to 1 million megohms to tolerances of ±0.02%.—Shallcross Mfg. Co., Collingdale, Pa.

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VOLTMETER. Two new 4-page Bulletins 325 and 7443 describe maker's ac-dc digital voltmeter and XY recorders, respectively.—Electro Instruments, Inc., 3794 Rosecrans St., San Diego, Calif.

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VOLT-OHMMETER. New 2-page Form 225K lists features and specification of Hickok's new Electronic Volt-Ohmmeter.—Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio.

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AMPLIFIER. New 2-page Specification 10 provides information on new Type 104 amplifier, designed for general laboratory applications where high input impedance and broad response is required.—Atlantic Research Corp., 901 North Columbus St., Alexandria, Va.

Circle **517** on inquiry card.

TEST OSCILLATOR. New 4-page Hewlett-Packard "Journal", Vol. 8 No. 5, contains information on RC Oscillator that covers the 20 cps-20 kc range in a single dial sweep.—Hewlett-Packard Co., 275 Page Mill Rd., Palo Atlo ,Calif.

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CURRENT TRANSFORMERS. New 4-page Bulletin 229 pictures and describes maker's "Type RA" precision multirange current transformers.—Knopp, Inc., 4224 Holden St., Oakland 8, Calif.

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SYNCHRONOUS ALTERNATOR. New 4-page Booklet describes the "Brushless", a new alternator with no brushes, no slip rings, no capacitors, no rotating parts but a smooth cylinder.—Bekey Electric Co., Inc., 1327 South Main St., Los Angeles 15, Calif.

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VOLTAGE REGULATOR. New 2-page Bulletin 9.00.1 discusses maker's models STR-150 and STR-300 transistor-magnetic regulators for 400 cycle atlernators.—Electric Regulator Corp., Norwalk, Conn.

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TRANSFORMERS, METERS ETC. New 8-page Bulletin 63 presents data on available pulse transformers, cathode ray tubes, lever switches, panel meters, etc,—Lectronic Research Labs., 715 Arch St., Philadelphia 6, Pa.

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POWER SUPPLIES. New 2-page bulletin provides information on maker's transistorized high-current regulated power supplies.—Electronic Research Associates, Inc., 67 East Centre St., Nutley ,N. J.

Circle **523** on inquiry card.

SWITCHES, RELAYS

LIMIT SWITCHES. New 8-page Bulletin 956 illustrates and describes maker's snap-action heavy duty switches.— R. B. Denison Mfg Co. 102 St. Clair Ave. N. W. Cleveland 13, Ohio.

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TIME DELAY RELAY. New 4-page Bulletin 516 describes maker's thermal time delay relay "with a memory."—Curtiss-Wright, Electronics Div., Carlstadt, N. J.

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MOTOR CONTROL. New 2-page bulletin describes maker's "Powerloid", an electromagnetic switch actuated by a solenoid plunger for control of motors up to 3 hp, and up to 8400 watt heater loads.—Guardian Electric, 1621 W. Walnut St., Chicago 12, Ill.

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MICRO SWITCH. New 2-page Data Sheet 116 describes new turn-to-lock-down lighted pushbutton switch. Micro Switch Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **527** on inquiry card.

RESISTORS, POTENTIOMETERS

PRECISION POTENTIOMETERS. New 2-page Catalog B-2 contains complete data on maker's Series RL-270 precision potentiometers with unlimited phasing.—The Gamewell Co., Newton Upper Falls 64, Mass.

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WIRE-WOUND RESISTORS. New 2-page Bulletin CB-2 describes maker's new Series CB precision wire-wound resistors featuring tension-free windings.—Kelvin Electric Co., 5907 Noble Ave., Van Nuys, Calif.

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POTENTIOMETERS. New 12-page Technical Paper 762 provides information on environmental effects on precision potentiometers.—Helipot Technical Information Service, Newport Beach, Calif.

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METAL FILM RESISTORS. New 4-page Bulletin B-3 provides information and diagrams on maker's type MEC and MEF resistors incorporating metallic resistive films.—International Resistance Co., 401 North Broad St., Phila. 8, Pa.

Circle **531** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

ELECTRICAL CONTACTS. New 4-page short-form catalog describes the materials, properties, forms and uses of maker's electrical contacts.—Gibson Electrical Co., 8381 Frankstown Ave., Pittsburgh 21, Pa.

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COPPER-CLAD PLASTIC. New 4-page Bulletin 755 describes characteristics of "Cirprint", a new copper-clad laminate specifically developed for printed circuits.—Formica Corp., 4411 Spring Grove Ave., Cincinnati 32, Ohio.

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STATOR WEDGES. New 2-page Specification Sheet D-11-30-56 contains information on Glastic U-Wedges—one-piece, molded, U-shaped stator-wedges for Class B electric motors.—The Glastic Corp., 4321 Glenridge Rd., Cleveland 21, Ohio.

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SUB-MINIATURE TERMINALS. Two new 2-page Bulletins MT-157S and MT-157F discusses maker's sub-miniature teflon-insulated stand-off, and feed-thru terminals, respectively.—Tri-Point Plastics, Inc., 175-177 I. U. Willets Road, Albertson, L. I., N. Y.

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MINIATURE PHOTOCONDUCTORS. New 8-page Bulletin TR-101 describes infrared-sensitive lead sulfide photoconductors for detection and guidance systems.—Electronics Corp. of America, Photoconductor-Transistor Div., one Memorial Drive, Cambridge 42, Mass.

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SOLENOID. New 2-page Folder 210-3 contains technical details on maker's "Kast-Coil", a waterproof solenoid coil.—Hays Mfg. Co., West 12th St., Erie, Pa.

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INSULATING FILMS. New 4-page Booklet E-PPTF describes properties of four types of PTF (polytetrafluoroethylene) electrical insulating films and tapes and their application.—Minnesota Mining and Manufacturing Co., Dept. D7-41, St. Paul, Minn.

Circle **538** on inquiry card.

MAGNETIC AMPLIFIER. New 2-page Specification Sheet 57-907 gives mechanical and electrical specifications of operational magnetic amplifier Type MA-61.—Dynamics Research Associates, Div. of Universal Match Corp., P. O. Box 5841, Ferguson 21, Mo.

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BERYLLIUM COPPER. New 4-page Bulletin 37 provides information on electrical parts made from Beryllium copper strip. Beryllium Corp., Reading, Pa.

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CABINET SLIDES. New 4-page Bulletin C-80 contains information and illustrations on the "EZ Mount" slide which runs on rollers for easing mounting of electronic equipment.—Chassis-Trak, Inc., 525 S. Webster, Indianapolis 19, Ind.

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TRANSFORMERS. New 24-page Catalog 157-T lists maker's miniature hermetically-sealed inductive components, featuring the geophysical (very low frequency) type.—Electro-Tech Pacific, P. O. Box 455, Goleta, Calif.

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RECORDING HEADS. New 8-page Catalog 1056-M describes maker's various types precision magnetic recording heads.—Electro-Tech Pacific, P. O. Box 455 Goleta, Calif.

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FLUORESCENT LIGHTING. New 24-page Booklet FL-578 provides information on fluorescent lamps, and features sections on the general advantages of fluorescent lighting.—Sylvania Electric Product Inc., 60 Boston St., Salem, Mass.

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SYSTEMS ENGINEERING. New 76-page Catalog No. 856-A provides information on company's electronic building blocks for systems engineer-

ing—Engineered Electronics Co., 506 East First St., Santa Ana, Calif.
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RECTIFIERS. New 2-page Bulletin No. 242 presents Siemens "Dwarf" rectifiers for half-wave type circuits. —Radio Rectifiers Co., Inc., 240 Wythe Ave., Brooklyn 11, N. Y.
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INVERTERS AND CONVERTERS. New 16-page catalog presents maker's semi-conductor and transistorized inverters and converters.—Electronic Research Assocs., Inc., 67 East Centre St., Nutley 10, N. J.
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ELECTRONIC COMPONENTS. Two new 2-page Catalogs 1157 and 1257 present maker's voltage supplies and ultra-sensitive electronic relays (including price list).—4-page illustrated price list presents surplus items, such as servo motors, generators, magnetic amplifiers, etc.—Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.
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PLUG-IN LIGHT. New 2-page bulletin illustrates and describes maker's incandescent and neon Pan-i-Lite bulbs.—Alden Products Co., 117 North Main St., Brockton 64, Mass.
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PLUG-IN COMPONENTS. New 4-page Bulletin describes "Encapsors," maker's plug-in electronic circuit components, hermetically embedded in thermosetting plastic.—Alcor Electronics Corp., 180 Lafayette St., New York 13, N. Y.
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WIRE

TEFLON-INSULATED Wire. New 4-page Catalog T-1 describes characteristics of maker's "teflon" insulated hook-up wire.—Alpha Wire Corp., 200 Varick St., N. Y. 4, N. Y.
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WIRE PROCESSING. New 4-page bulletin pictures and describes "Model 810" automatic wire cutting and stripping machine.—Eubanks Engineering Co., 260 N. Allen Ave., Pasadena, Calif.
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WIRE MARKERS. New 2-page Data Sheet contains information on tubular plastic wire-markers.—E. C. P. Corp., 6808 Wade Park Ave., Cleveland 3, Ohio.
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WIRE PLIER. New 6-page bulletin contains information on maker's "Wizard" plier for stripping and adding loop to ends of insulated wires.—United States Research Corp., Bear Tavern Rd., Trenton 8, N. J.
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WIRE STRIPPER. New 2-page Bulletin provides information on maker's wire stripper designed to strip either single or multiple-strand magnet wire, AWG No. 18 to AWG No. 48.—Thomas Instrument Co., Phoenix, N. Y.
Circle **555** on inquiry card.

CONTROL PANEL WIRING. New 8-page Bulletin S-301 outlines techniques for wiring of electrical and electronic equipment.—Stahlin Brothers, Inc., 399 Maple St., Belding, Mich.
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MECHANICAL COMPONENTS

FLAT DIAPHRAGMS. New 4-page "Instrument Notes" No. 31 describe the characteristics of flat annular diaphragms.—Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif.
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BALL BEARINGS. New 28-page Catalog 57 contains explanation of new bearing design with split outer race, and complete information on bearing sizes available. Split Ballbearing Corp., Lebanon, N. H.
Circle **558** on inquiry card.

SPRING DESIGN. New 84-page Manual contains comprehensive information on spring design for all types, with formula, physical properties of materials, tables etc.—Associated Spring Corp., Bristol, Conn.
Circle **559** on inquiry card.

MATERIALS

SPRING STEELS. New 52-page catalog describes maker's cold-rolled spring steels, and tabulates properties. —Wallace Barnes Steel Div. of Associated Spring Corp., Bristol, Conn.
Circle **560** on inquiry card.

SILICONE FLUIDS. New 4-page Brochure 3-106 contains physical and electrical characteristics of silicone fluids and general application information.—Dow Corning Corp., Midland, Mich.
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KARAK. New 2-page Form 1174 describes "Karak", a carbon-graphite material available in various grades and blends of graphite and other forms of carbon used for pump vanes, rotors, end plate bearings, etc.—The Ohio Carbon Co., 12508 Berea Rd., Dept. 187, Cleveland 11, Ohio.
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SILICONE. New 8-page Catalog CDS-97 describes typical silicone uses such as for rubber products, cosmetics, polishes, electrical insulation, water repellents, textile finishes, lubricants, release and antifoam agents.—General Electric, Silicone Products Dept. Waterford, N. Y.
Circle **563** on inquiry card.

PERMANENT MAGNETS. New 12-page Catalog PM-121 provides information on cast Alnico 5, and sintered Alnico.—General Electric Co., Magnetic Materials Section, Edmore, Mich.
Circle **564** on inquiry card.

HEAT-RESISTING ALLOYS. New 2-page issue of "Techalloy Tidings" Vol. 2, No. 1) presents selector chart for maker's high temperature alloys. —Techalloy Co., Inc., Rahns, Pa.
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TUNGSTEN CARBIDE. New 2-page Bulletin L-501 presents characteristics of maker's "Kennametal Grade K501"

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NEW LITERATURE

a tungsten carbide with platinum binder.—Kennametal, Inc., Latrobe, Pa.

Circle **566** on inquiry card.

HIGH-TEMPERATURE ALLOYS. New 20-page catalog describes high-strength alloys for elevated temperatures, heat treatment, forging, information etc.—The Carpenter Steel Co., 3062 West Bern St., Reading, Pa.

Circle **567** on inquiry card.

MAGNESIUM AND TITANIUM. New 44-page booklet gives complete data on properties of Magnesium and Titanium.—Brooks & Perkins, Inc., 1950 West Fort St., Detroit 16, Mich.

Circle **568** on inquiry card.

FABRICATION

PANTOGRAPH ENGRAVERS. New 14-page Catalog No. 57 illustrates and describes maker's line of pantograph engraving machines and accessory items.—Micro Instrument Co. 80 Trowbridge St., Cambridge 38, Mass.

Circle **569** on inquiry card.

GRINDER CONTROL. New 12-page bulletin illustrates and describes maker's "Microtrol" type 150 control system for plunge grinders. Includes 4-page price list.—Airborne Instrument Lab., Inc., 160 Old Country Rd., Mineola, N. Y.

Circle **570** on inquiry card.

WELDING CONTROL. New 8-page Bulletin GEA-5945A discusses maker's control equipment for resistance welding.—General Electric Co., Schenectady 5, N. Y.

Circle **571** on inquiry card.

MAGNETIC SHIELDING. New 18-page Bulletin 122 presents methods of fabricating maker's non-shock sensitive, non retentive mganetic shielding material.—Magnetic Shield Div., Perfection Mica Co., 20 N. Wacker Drive, Chicago 6, Ill.

Circle **572** on inquiry card.

CHROMIZING PROCESS. New 8-page Bulletin 3-1 describes maker's process of diffusing chrome for making iron and steel parts corrosion resistant.—Chromalloy Corp., 450 Tarrytown Rd., White Plains, N. Y.

Circle **573** on inquiry card.

GRINDER-CONTROL. New 8-page bulletin discusses maker's "Inchworm Motor" specifically designed for feed control on centerless grinders.—Airborne Instruments Lab., Inc., Mineola, L. I., N. Y.

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SLICING MACHINE. New 4-page Form 56-70 describes fast automatic machine designed specifically for machining of brittle, shock-sensitive materials such as germanium, silicon, quartz, ceramics and carbides.—The DoAll Co., Des Plaines, Ill.

Circle **575** on inquiry card.

HEAT TREATING FURNACES. New 4-page, Bulletin SC-177 describes and illustrates maker's continuous heat treating furnaces.—Surface Combustion Corp., 2375 Dorr St., Toledo 1, Ohio.

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STEEL MARKINGS. New 10-page bulletin describes maker's "Ateenate" process for producing permanent Jet Black markings on stainless steel.—Photo Chemical Products, 470 Walton Ave., New York, N. Y.

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NEW LITERATURE

SURFACE FINISH INDICATOR. New 2-page Bulletin MS-2656 describes the "Micro Surfit" for determining surface finish in micro inches by comparsion or by direct measurement.—Micro Surfit, Saratoga Scientific, Saratoga, Calif.

Circle **578** on inquiry card.

MARKING MACHINES. Eighteen new 2- and 4-page Bulletins (146-C3 through C10, 146C-12 through C20 and 146-C23) describe maker's metal marking machines.—Jas. H. Matthews & Co., Pittsburgh 13, Pa.

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MISCELLANEOUS

PH ELECTRODES. New 4-page Data Sheet NS 5(2) discusses and illustrates features of immersion heads, and stainless steel mountings for pipeline pH measurements.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

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MARKING NUMBERS. New 6-page Bulletin 165 provides information on self-sticking, all-purpose numbers and letters.—W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 12, Wis.

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CAREER OPPORTUNITIES. New 32-page Booklet L-199 describes scientific and engineering-career opportunities in the optical industry.—Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.

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SCIENCE, TECHNOLOGY PROGRESS. New 12-page Booklet GP-44 provides information on scientific news of 1956 as disseminated by radio station WGY.—General Electric Research Lab., Schenectady, N. Y.

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RESEARCH REPORTS. New 24-page booklet PRG-110 provided information on scientific developments which have resulted from work in GE's 42 major laboratories.—General Electric Co., Dept. 2-119, Schenectady, N. Y.

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NAMEPLATES. New 4-page bulletin describes maker's new method of manufacturing nameplates by etching markings through enameled surfaces.—Photo Chemical Products, 4790 Walton Ave., New York 51, N. Y.

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DENTAL SUPPLIES. New 24-page catalog lists maker's orthodontic supplies, and description of their uses.—Orthodontic Specialty Lab., 1827 Spruce St., Phila. 3, Pa.

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PETROCHEMICAL PIPELINES. New 4-page Reprint MRI-206 discusses possibility of petrochemical pipelines bringing plants to Midwest.—Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo.

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MATHEMATICAL PUZZLES. New 36-page Booklet "Fascination in Numbers" explains numerical problems and describes use of Graham Computer (a sort of slide rule available with compliments of company.)—Graham Transmissions Inc., Menomenee Falls, Wis.

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PRODUCTS AND PROCESSES. New 28-page booklet provides information and a pictorial review of company's mining, smelting, refining and research operation.—American Smelting and Refining Co., 120 Broadway, New York 5, N. Y.

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GLASS PRODUCTS. New 6-page bulletin presents list of maker's products.—Corning Glass Works, Corning, N. Y.

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RESEARCH FACILITIES. New 24-page Bulletin S-1053 describes and illustrates the firm's contract research facilities. Selas Corp. of America, Dresher, Pa.

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RADIATION SAFETY SERVICE. New 8-page brochure provides information on company's film and neutron badge service for personnel monitoring of X-ray, gamma, beta, and neutron exposures.—R. S. Landauer, Jr. & Co., 24 Plaza, Park Forest, Ill.

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CONVEYORS. New 160-page illustrated Catalog M4 describes maker's "Monoveyor" overhead conveyor.—Mechanical Handling Systems, Inc., Detroit, Mich.

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MICROWAVE EQUIPMENT. Eight new 2-page Bulletins (2009, 4063, 4421, 4432, 5802, 9303, 9306 & 9310) provide information on components for microwave equipment.—Bogart Mfg. Corp., 315 Seigel St., Brooklyn 6, N. Y.

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PANTOGRAPH. New 2-page bulletin describes and prices maker's "Mico" Series 600 heavy duty pantographs for engravinig.—Mico Instrument Co., 80 Trowbridge St., Cambridge, Mass.

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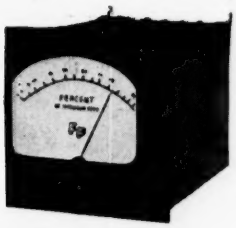
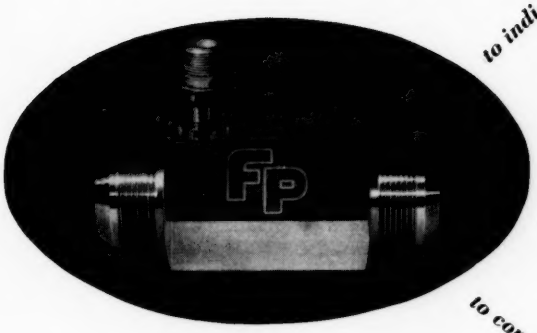


PANEL FLOW RATE INDICATOR

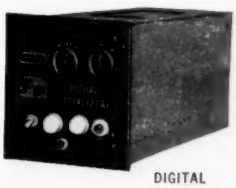
to indicate flow

to indicate steady state flow condition

IN-LINE DIGITAL INDICATOR

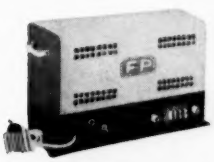


to totalize flow for batch processes



DIGITAL TOTALIZER

to convert transient flow for analog output



FREQUENCY MULTIPLIER-CONVERTER

get flow information in any form you need it

. . . with F&P turbine meters and readout devices

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The low inertia, axially balanced rotor of the F&P turbine meter gives optimum response to rapidly changing flow rates . . . providing positive information on changes as soon as they *begin*, not after they happen. A basic frequency output, directly proportional to flow, provides a common language easily fed to indicating, recording, or transmitting equipment. You can have digital or analog indication . . . oscilloscope recording . . . circular or strip chart recording . . . digital totalizing . . . transmission or any combination of these. Here are just a few of the Fischer & Porter output devices you can dovetail with one or more turbine meters:

PANEL FLOW RATE INDICATOR: Provides scale reading in desired flow units or in percentage of maximum flow. Includes amplifier which may be used to feed EPUT meters or integrators, and analog converter.

"IN-LINE" DIGITAL INDICATOR: Direct digital readout of flow information in desired gravimetric or volumetric units. Automatically selects turbine meter outputs by flow range.

DIGITAL TOTALIZER: Provides integrated flow information accurate to ½%.

FREQUENCY MULTIPLIER-CONVERTER: Extremely rapid response to transient flow signals. Sampling of eight points per cycle provides more information than conventional means.

For complete data on the F&P turbine meter and some of the systems it makes possible, write for catalog. Address request to Fischer & Porter Co., 347 County Line Road, Hatboro, Penna.

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Complete Process Instrumentation

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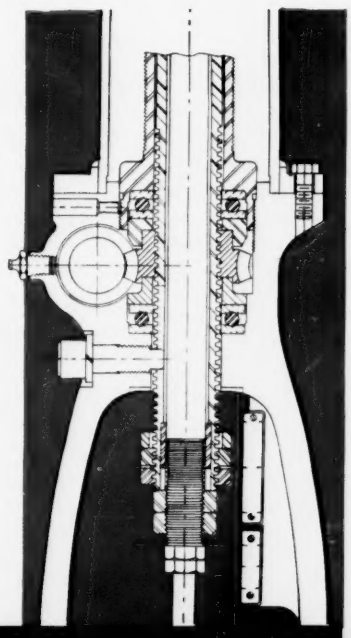

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